HYDRAULIC-PRESSURE TEST OF OXY-ACETYLENE AND SCREWED PIPE CONNECTIONS

Size pipe in.	Type joint	Pressure at failure, lb. per sq. in.	Maximum pressure, lb. per sq. in.	Nature of failure	Condition of weld
2	Welded 'T'	4400	4400	Tube seam split	O.K.
2	" "	2200	2200	Leak in tube seam	O.K.
2	" "	4750	4750	Tube seam split	O.K.
2	Screwed 'T'	2350	2750	Sand holes in fitting	....
2	" "	500	2000	Sand holes in fitting	....
3	Butt weld	....	5300		O.K.
3	" "	4950	4950	Tube seam split	O.K.
3	" "	....	4250		O.K.
3	Coupling	3950	3950	Coupling split	....
3	"	3400	4400	Leak in coupling	....
3	Welded 'T'	....	3500		O.K.
3	" "	....	4250		O.K.
3	" "	....	3505		O.K.
3	Screwed 'T'	350	2700	Sand holes in fitting	....
3	" "	300	3100	Sand holes in fitting	....
4	Butt weld	....	5100	Pipe bulged	O.K.
4	" "	....	3250		O.K.
4	Coupling	300	3000	Leak at threads	....
4	"	750	2600	Leak at threads	....
4	Welded 'T'	3850	5100	Leak in weld	Leaked
4	Screwed 'T'	1000	1950	Sand holes in fitting	....

EXPANSION-JOINTS IN CONCRETE PAVEMENTS

Asphaltic products are usually used for expansion-joints in concrete pavements and other concrete surfaces. Being black they absorb heat and the temperature of the expansion-joint is higher than the surrounding air. At one test the temperature of the expansion-joint was 130° F. when the temperature of the air was only 85° F. Petrolastic cement is suitable for this class of work because it has a higher melting-point and is generally less susceptible to temperature-changes than ordinary asphaltum, and has also good binding and waterproofing power.

Book Reviews

How to Study. By George F. Swain. Pp. 66. The McGraw-Hill Book Co., Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, 25 cents.

The author, who is eminent both as a consulting engineer and as a teacher, has included in this small volume a few suggestions both as regards methods of study and the general attitude of mind that the student should have when endeavoring to acquire, not so much knowledge as wisdom. The statements are enforced both by the author's arguments and by quotations from the sages of many epochs, from Solomon and Epicurus to George Horace Lorimer. While primarily for the engineering student and the professor of engineering, the book should be of value to the practising engineer, or for that matter to anyone who realizes that he has not finished learning.

Handbook of Clearing and Grubbing Methods and Cost. By H. P. Gillette. Pp. 232. Ill., index. Clark Book Co., Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $2.50.

At first thought it might appear that a book having this title would be more suitable for the farmer than the engineer and contractor. However, while the farmer, particularly on logged-off land, needs a book of this character, the engineer and contractor also have much clearing and grubbing to do, and the cost of this work is in many cases a large part of the cost of construction. Moreover, the reclamation of logged-off lands can usually be done most economically when the work is on a large scale, permitting the use of expensive equipment and the employment of men trained to the work. The author has drawn on his own experience and the published notes of others in his discussion of methods and cost. He shows clearly that the usual specifications, particularly the method of payment per acre cleared and grubbed, frequently results in injustice to the contractor, and consequently in high unit bids. Especially with regard to grubbing, he recommends payment on the basis of number and size of all large stumps. This is particularly important in highway construction, where the roadbeds are usually wider and the cuts shallower than in railroad work. The removal of stumps by burning and by char-pitting is discussed fully, as well as blasting and the use of stump-pullers. The book will be useful to anyone who has occasion to do any of the work described.

Report of the State Water Commission of California. P. 183. Illustrated, with two maps in insert.

This report covers the period from March 1, 1915, to December 1, 1916, or practically the entire period when the present commission has been working under the Water Commission Act. During this period 531 applications for permis- to divert water were received, of which 192 were granted, 50 rejected, and 39 withdrawn, the remainder being still pending. The report gives the Water Commission Act and the proposed amendments to the Act. Several aspects of the water-supply question are discussed and there is a list of the applications received and a set of forms and directions for applications.

Spray Irrigation. By Milo B. Williams. Bulletin No. 495, U. S. Department of Agriculture. Pp. 40. Ill. A fair average cost for construction of a spray-irrigation system is $250 per acre, and this system of irrigation is not recommended unless increased annual returns of at least $51 per acre can be secured.

Special Road Laws of Oregon. Compiled by G. Ed. Ross, secretary State Highway Commission. State Printing Office, Salem. Pp. 36. Contains the new highway laws passed by the 1917 legislature.

Electrical Utilization Safety Orders. Industrial Accident Commission. Pp. 53. Index. These orders are effective July 1, 1917.

Civil Service Examinations

Mechanical Laboratory Assistant, Bureau of Mines, August 22. Salary, $960 to $1080. At least two years' college work in science required. Age limit 21 to 40. Usual places of examination. Application form 1312.

Junior Gas Chemist, Bureau of Mines, August 22. Salary, $1200 to $1500. Graduation in chemistry or chemical engineering required. Competitors will be examined in the following subjects: general qualitative and quantitative chemistry, gas-analysis, and general physics. Age 21 to 35. Usual places of examination. Application form 1312.

Junior Land Classifier, Geological Survey. Salary, $1080 to $1200. Applicants will not be assembled for examination but will be rated on the following subjects: surveying and mapping, mathematics, and either agronomy, animal husbandry, or irrigation engineering. Applications will be received at any time. Graduation from a university in agriculture or civil engineering is required. Age 20 to 35. Application form 1312.

Laboratory Assistant, Bureau of Standards. Salary, $1000 to $1320. Applicants will not be assembled for examination but will be rated upon the following subjects: elementary physics, mathematics, and chemistry, and either advanced physics, electrical, civil, or mechanical engineering, paper technology, textile technology, or ceramics. Graduation from a technical school required. Applications will be received at any time. Age 20 to 35. Application form 1312.

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Engineering Societies

IDAHO SOCIETY OF ENGINEERS. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Ford W. Harris, secretary, 1029 Higgins building.

Los Angeles Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Edward Woodbury, secretary, 255 East 3rd street.

OREGON SOCIETY OF ENGINEERS. Orrin E. Stanley, secretary, room 409, City Hall, Portland.

Portland Section, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Paul Lebenbaum, secretary, 45 Union Depot.

Portland Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. J. A. Currey, secretary, 194 North 13th street, Portland.

San Francisco Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. E. T. Thurston, Jr., secretary, Mechanics Institute building.

San Francisco Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Carl F. Braun, secretary, Hooker & Lent building.

San Francisco Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. A. G. Jones, 811 Rialto building.

Southern California Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. Wilkie Woodard, secretary, 435 Consolidated Realty building, Los Angeles.

UTAH SOCIETY OF ENGINEERS. Hugh C. Lewis, secretary, Capitol building, Salt Lake City, Utah.

The last meeting of the OREGON SOCIETY OF ENGINEERS for the summer of 1917 was held on Thursday evening, June 28. No meetings will be held during the months of July and August.

Coming Conventions

AMERICAN ELECTRO-CHEMICAL SOCIETY. Annual convention, Pittsburg, Pennsylvania, October 3-6.

Personal

CHARLES EVAN FOWLER of Seattle is in New York.

R. W. VAN NORDEN has removed his offices to the Alaska Commercial Bdg., San Francisco.

EDGAR M. WHITLOCK, formerly of the San Francisco contracting firm of Whitlock & Gorrill, is with the Eighth Regiment, Reserve Engineers.

CHARLES B. WING, professor of structural engineering at Stanford University, has been commissioned major in the Engineer Officers' Reserve Corps.

J. J. ROSENTHAL, safety engineer for the Industrial Accident Commission of California, has been commissioned captain in the Engineer Officers' Reserve Corps.

J. SHIRLEY BRIGHT, formerly county surveyor of San Bernardino county, California, has been appointed senior highway engineer for the U. S. Office of Public Roads.

J. R. HOLMAN, formerly chief engineer for the Oregon-Washington Railroad & Navigation Co. has been commissioned lieutenant-colonel of the Eighth Regiment, Reserve Engineers.

BORIS BAKHMETEFF, a Russian civil engineer who spent considerable time in engineering work in the United States, about 1907, has been appointed Russian Ambassador to the United States.

SAMUEL FELTON, president of the Chicago & Great Western Railway Co. has been appointed director-general of railways at the front under General WILLIAM BLACK, chief of engineers for the U. S. Army.

CHARLES H. LEE has been commissioned captain in the Engineer Officers' Reserve Corps. Mr. Lee has been at the training camp at Vancouver, Washington, and is now in Los Angeles on leave of absence.

CARL H. REEVES, formerly a consulting engineer of Seattle and now captain in the Engineer Officers' Reserve Corps, has been appointed superintendent of construction of the militia cantonment near Menlo Park, California.

COERT DU BOIS, formerly U. S. district forester in charge of the National Forests in California, has been commissioned major of the Tenth Regiment, Reserve Engineers. This is a regiment of woodsmen and foresters. R. M. HEADLEY has succeeded him as district forester.

CHARLES N. BLACK, formerly vice-president and general manager of the United Railroads of San Francisco, and a member of the firm of Ford, Bacon & Davis, has been made manager of exports for J. P. Morgan & Co., in which capacity he will have charge of all purchases for the Allies in the United States.

HOMER HAMLIN, formerly city engineer of Los Angeles, has been discharged from that position by the Board of Public Works. Mr. Hamlin's discharge is the climax of several years of lack of harmony between him and the members of the board. He has been succeeded by ANDREW C. HANSEN, formerly chief deputy city engineer.

JOSEPH A. KITTS has been appointed captain in the Engineer Officers' Reserve Corps. Mr. Kitts was one of the civilian engineers on the Panama Canal under Colonel (now Major-General) W. L. Sibert, division engineer of the Atlantic (Gatun locks and dam) division. General Sibert is now in command of U. S. troops at the front in France.

Commercial Paragraphs

CHARLES M. WOODS, of the firm of Woods, Huddart & Gunn, of San Francisco, has severed his connections with that firm.

A. N. EASON and A. N. GARLAND have entered into partnership for handling general contracting work with offices at 815 Green Bdg., Seattle.

R. C. STORRIE & Co., builders of the Twin Peaks tunnel, Mile Rock tunnel, and other engineering works, have opened offices in the Crocker building, San Francisco.

J. H. JOWETT, formerly general sales manager for the Ingersoll-Rand Co. has been elected vice-president of the company and L. D. ALBIN, formerly assistant general sales manager, has been appointed general sales manager. Mr. Jowett and Mr. Albin will continue to make the company's New York offices their headquarters.

The following new publications have been issued by the INGERSOLL-RAND CO.: Form 8006, 20-page catalogue describing Imperial motor-hoists and stationary motors. Form 8212, 4-page bulletin on the Crown coal-pick and core-breaker. Form 8213, 16-page booklet on Little David pneumatic chipping, calking, and scaling hammers. Form 9102, 8-page bulletin on air-receivers, pressure-tanks, and moisture-traps.

The Blaw Steel Construction Co. and the Knox Pressed & Welded Steel Co. consolidated on July 1, under the name of the BLAW-KNOX CO. The plants of both companies will be continued in operation. At the Blaw plant will be manufactured steel for mill buildings, transmission-towers, and steel forms for concrete construction, also clamshell buckets. At the Knox plant the Knox open-hearth doors, door-frames, ports and reversing-valves, pressed and welded steel specialties, and steel plates will be manufactured. The Pacific Coast office of the company is at 503 Rialto Bdg., San Francisco, in charge of E. M. Ornitz.

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Western Engineering

WEEKLY NEWS BULLETIN

WESTERN ENGINEERING *with* WEEKLY NEWS BULLETIN $4.50 per Year

SAN FRANCISCO, AUGUST 6, 1917

SINGLE COPIES WEEKLY NEWS BULLETIN 15 Cents

Contracts Pending

Bids will be Received		See Issue of News Bulletin
Aug. 6.	Coalinga, Cal., Supplies	Aug. 6
Aug. 6.	Coalinga, Cal., Water Supply	Aug. 6
Aug. 6.	Los Angeles, Cal., Road Work	Aug. 6
Aug. 6.	Los Angeles, Cal., Street Work	Aug. 6
Aug. 6.	Paso Robles, Cal., Water Supply	Aug. 6
Aug. 6.	Sacramento, Cal., Road Work	July 23
Aug. 6.	San Diego, Cal., Sewers	Aug. 6
Aug. 6.	San Diego, Cal., Street Work	Aug. 6
Aug. 6.	San Jose, Cal., Bridges	July 23
Aug. 6.	San Jose, Cal., Road Work	July 23
Aug. 6.	San Leandro, Cal., Street Work	July 30
Aug. 6.	San Mateo, Cal., Road Work	Aug. 6
Aug. 6.	San Rafael, Cal., Street Work	July 30
Aug. 6.	Santa Ana, Cal., Bridges	July 30
Aug. 6.	Sonora, Cal., Miscellaneous	July 30
Aug. 6.	Venice, Cal., Building	Aug. 6
Aug. 6.	Washington, D. C., Building	July 23
Aug. 6.	Washington, D. C., Supplies	July 30
Aug. 7.	Ceres, Cal., Building	July 30
Aug. 7.	Colville, Wash., Street Work	Aug. 6
Aug. 7.	Los Angeles, Cal., Supplies	Aug. 6
Aug. 7.	Merced, Cal., Building	July 23
Aug. 7.	Pasadena, Cal., Supplies	Aug. 6
Aug. 7.	Portland, Ore., Bridges	Aug. 6
Aug. 7.	Salem, Ore., Road Work	Aug. 6
Aug. 7.	San Rafael, Cal., Road Work	July 30
Aug. 7.	Sedro Woolley, Wash., Road Work	July 30
Aug. 7.	South Bend, Wash., Bonds	July 23
Aug. 7.	Tracy, Cal., Irrigation	July 30
Aug. 7.	Wallace, Ida., Street Work	July 30
Aug. 7.	Washington, D. C., Machinery and Supplies	July 30
Aug. 8.	Auburn, Cal., Street Work	July 30
Aug. 8.	San Francisco, Cal., Machinery	July 23
Aug. 8.	San Francisco, Cal., Street Work	July 30
Aug. 8.	San Jose, Cal., Bridge	July 30
Aug. 8.	San Jose, Cal., Street Work	July 30
Aug. 8.	San Jose, Cal., Water Supply	July 30
Aug. 8.	Santa Ana, Cal., Building	July 30
Aug. 8.	Santa Ana., Cal., Street Work	July 30
Aug. 9.	Palo Alto, Cal., Buildings	July 30
Aug. 9.	Vancouver, Wash., Bridges	July 23
Aug. 10.	Berkeley, Cal., Sewer	Aug. 6
Aug. 10.	Boise, Ida., Road Work	Aug. 6
Aug. 13.	Fairfield, Cal., Bridge	July 30
Aug. 13.	Ketchikan, Alaska, Miscellaneous	July 23
Aug. 13.	Ketchikan, Alaska, Miscellaneous	July 30
Aug. 13.	Lewiston, Ida., Street Work	July 30
Aug. 13.	Olympia, Wash., Supplies	Aug. 6
Aug. 13.	Richmond, Cal., Harbor Work	Aug. 6
Aug. 13.	Richmond, Cal., Street Work	Aug. 6
Aug. 13.	Sacramento, Cal., Road Work	Aug. 6
Aug. 13.	Sacramento, Cal., Supplies	Aug. 6
Aug. 13.	San Francisco, Cal., Supplies	Aug. 6
Aug. 13.	Tulare, Cal, Street Work	Aug. 6
Aug. 13.	Washington, D. C., Building	Aug. 6
Aug. 14.	Davis, Cal., Drainage	Aug. 6
Aug. 14.	Red Bluff, Cal., Bridges	July 30
Aug. 14.	Twin Falls, Ida., Buildings	Aug. 6
Aug. 14.	Ventura, Cal., Bridge	July 30
Aug. 15.	Hanford, Cal., Sewers	Aug. 6
Aug. 16.	Astoria, Ore., Bridges	July 30
Aug. 16.	Bonners Ferry, Ida., Road Work	Aug. 6
Aug. 16.	Copper Hill, Ariz., Building	Aug. 6
Aug. 16.	Santa Barbara, Cal., Street Work	Aug. 6
Aug. 17.	Santa Rosa, Cal., Bridge	Aug. 6
Aug. 18.	Bakersfield, Cal., Building	Aug. 6
Aug. 18.	Columbia Falls, Mont., Miscellaneous	Aug. 6
Aug. 20.	Clifton, Ariz., Bridge	Aug. 6
Aug. 20.	Olympia, Wash., Road Work	Aug. 6
Aug. 20.	Sacramento, Cal., Road Work	July 30
Aug. 20.	Sacramento, Cal., Building	Aug. 6
Aug. 21.	Seattle, Wash., Road Work	Aug. 6
Aug. 22.	Modesto, Cal., Building	July 30
Aug. 22.	San Francisco, Cal., Bonds	Aug. 6
Aug. 27.	Sacramento, Cal., Road Work	Aug. 6
Aug. 28.	El Centro, Cal., Bonds	Aug. 6
Aug. 30.	Portland, Ore., Supplies	Aug. 6
Sept. 5.	San Francisco, Cal., River Work	Aug. 6
Sept. 5.	Torrington, Wyo., Irrigation	Aug. 6
Oct. 1.	Bangkok, Siam., Machinery and Supplies	July 30

Building Permits

In SAN FRANCISCO; $2500 and over in valuation.

JULY 25

TWO STORY BUILDING ALTERATIONS—Cost $5500. N. and F. Prost, owners. Fulton 82-6 E 18th Ave.

DINING ROOM ALTERATIONS—Cost $50,000. St. Francis Hotel, owner. Powell St.

TWO STORY FRAME FLATS—Cost $4000. John Payne, owner. 19th Ave 225 N Cabrillo.

TWO STORY BRICK AUTO SALESROOM—Cost $15,000. Mrs. D. Samuels, owner. SE Ivy and Van Ness Ave.

JULY 27

ELEVATOR INSTALLATION—Cost $2500. Mr. Smith, owner. 2027 California.

RESTAURANT ALTERATIONS—Cost $2500. Mangels Estate Co., owner. 78-80 Ellis.

ONE STORY BRICK REPAIR SHOP—Cost $6000. O. Roemer, Sr., owner. W Gough 137-6 N Grove.

JULY 30

STORES ALTERATIONS—Cost $3500. Leo Pockwitz, owner. SW Embarcadero and Washington.

AUGUST 2

ONE STORY CONCRETE AND BRICK GARAGE—Cost $14,000. M. & M. Righetti, owner. California and Locust.

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Construction News

STREET AND ROAD WORK

BOISE, IDA.—Bids will be received until August 10 by W. T. Dougherty, secretary State Highway Commission, for construction of 44 miles of North and South highway in Adams county.

BONNERS FERRY, IDA.—Bids will be received until August 16 by R. S. McCrea, county clerk, for construction of road No. 373.

COLVILLE, WASH.—Bids will be received until 8 p.m., August 7, by J. C. Hard, city clerk, for improvement of several streets.

GLENDALE, CAL.—Contract for improvement of Grandview avenue has been awarded to P. L. Ferry, 536 East Acacia street, Tropico, for $586.20.

LOS ANGELES, CAL.—Board of Public Works will receive bids until August 6 for grading, oiling, and construction of concrete curbs, gutters, and sidewalks on Springvale drive.

Bids will be received until 2 p.m., August 6, by Board of Supervisors for construction of 0.454 mile of concrete pavement in road district No. 90. County will furnish materials. Estimated labor cost is $1891.

Contract for improvement of McPherson street and Wall street has been awarded to George H. Oswald, O. T. Johnson Bdg., Los Angeles, at $12,747.96 and $3957.90, respectively.

Contract for improvement of Sierra street has been awarded to S. McCray, 469 West Avenue 52, Los Angeles, for $4564.81.

OAKLAND, CAL.—Contract for improvement of Mitchell street has been awarded to Hutchinson Co., 13th and Franklin streets, Oakland, at the following unit prices: grading, 2½c. per sq. ft.; concrete curbs, 40c. per ft.; concrete gutters, 14c. per sq. ft.; oil-macadam pavement, 10c. per square foot.

OGDEN, UTAH.—P. J. Moran Co., Salt Lake City, was low bidder at $1.74 per sq. yd. or $126,049.94 in all for paving South Washington avenue, using sheet asphalt on 6-in. concrete base. J. P. O'Neill Construction Co. bid $136,453 using sheet asphalt, and Strange-Maguire Paving Co. bid $146,325.86 using bitulithic.

OLYMPIA, WASH.—Bids will be received until August 20 by State Highway Commission for construction of part of state highway No. 21 between Clifton and Charleston, 10 miles. Estimated cost is $80,000.

PASADENA, CAL.—Contract for improvement of several streets has been awarded to T. C. Breitenstein, 465 Van Wyck street, Pasadena, for $3906.86.

PORTLAND, ORE.—Following were the low bidders on various section of state highway work: Rainier Hill, A. L. Clark, Rainier, Wash., $11,888; Globe-Warren Construction Co., Portland, $42,300; Ruthton Hill, Cascade Locks, and Viento, A. D. Kern, at $39,383; $105,920, and $79,399 respectively.

RICHMOND, CAL.—Plans have been completed by city engineer H. D. Chapman, for construction of pavement on Western drive and call for bids will be issued soon.

Bids will be received until August 13 by A. C. Faris, city clerk, for grading and construction of macadam pavement and concrete curbs, gutters, and sidewalks on 19th street.

SACRAMENTO, CAL.—Bids will be received until 10 a.m., August 13, by E. F. Pfund, county clerk, for construction of the Plymouth road, the Pocket road, and part of the H-street road.

State Highway Commission will receive bids until August 27 for the following state highway work: In Contra Costa county, between Hercules and Eckley, 5.7 miles, to be paved with concrete. In Contra Costa county, between Martinez and Eckley, 7 miles, to be paved with concrete. In Los Angeles county, between Castaic school and Kay Ranch, 3.8 miles, to be paved with concrete. Plans at office of commission or at the offices of division engineers at San Francisco and Los Angeles.

Detailed figures regarding the state highway work in Shasta county between Sacramento river and Lamoine, 13.3 miles, bids for which are to be received until 2 p.m., August 20, by State Highway Commission, are now available. The work includes 151,000 cu. yd. excavation, 4600 ft. of 12 to 24-in. corrugated pipe, 1600 cu. yd. concrete in culverts, monuments, and retaining-walls, 750 cu. yd. rubble masonry and 300 cu. yd. dry rubble masonry in retaining-walls, 1.5 miles new property-fences, 1.5 miles moving and resetting fences, 200 cu. yd. slope paving, and 610 monuments. State will furnish pipe railing for culverts, reinforcing steel, corrugated metal pipe, cement, and all materials for new fences.

SALEM, ORE.—Bids will be received until 1 p.m., August 7, by State Highway Commission for construction of 70 miles of macadam highway in various parts of the State.

SALEM, ORE.—Bids will be received until August 7 by State Highway Commission for grading and paving five miles of highway between Tillamook and Cloverdale.

SAN BRUNO, CAL.—Contract for improvement of several streets has been awarded to Municipal Improvement Co., 803 Macdonald avenue, Richmond, for $44,561.

SAN DIEGO, CAL.—Bids will be received until August 6 by A. H. Wright, city clerk, for construction of 136,575 sq. ft. of 4-in. concrete pavement with asphaltic-oil wearing surface.

Contract for grading 33rd street has been awarded to G. R. Daley, McNeece Bdg., San Diego, for $8299.

Rooney-Wyckoff Co., Consolidated Realty Bdg., Los Angeles, was low bidder at $52,117.98 for construction of section No. 1 of concrete highway to Linda Vista cantonment. Other bidders were: John Engebretsen, $53,932.04; H. Fenton, $54,803.83; Fairchild-Gilmore-Wilton Co., $57,431.32. John Engebretsen, 614 Fifth street, San Diego, was low bidder at $22,146.27 for construction of section No. 2 of highway. Other bidders were: H. G. Fenton, $25,556.08; T. C. Breitenstein, $27,447.

SAN FRANCISCO, CAL.—Board of Public Works has awarded the following contracts for street work: concrete sidewalks on Jessie street to Frank O'Shea for $2402.36; asphalt pavement and concrete curbs and sidewalks on Arkansas street to Federal Construction Co., Sharon Bdg., San Francisco, for $12,539.80; asphalt and basalt-block pavement and basalt-block gutters on Hancock street to Flinn & Treacy, First National Bank Bdg., San Francisco, for $5467.93; grading Rhode Island street to Federal Construction Co. for $7915.

Contract for grading one block on Wisconsin street has been awarded to C. B. Eaton, 407 11th street, San Francisco.

Contract for construction of sidewalks on Fifth street has been awarded to Frank O'Shea.

SAN MATEO, CAL.—Bids will be received until 8 p.m., August 6, by E. F. Early, city clerk, for improvement of El Camino Real and the Crystal Springs road.

SANTA BARBARA, CAL.—Bids will be received until noon, August 16, by A. C. Hall, city clerk, for construction of warrenite pavement on concrete base for 17 blocks on Bath street. Estimated cost is $65,000.

SEATTLE, WASH.—Quigg Construction Co. was only bidder at $47,606 for construction of final link of Cascade scenic highway, 5½ miles. Engineer's estimate was $44,280.

County commissioners will receive bids until August 21 for grading and graveling 1½ miles of permanent highway No. 2-G. Estimated cost is $15,000.

Contract for grading 5½ miles of Cascade scenic highway has been awarded to Quigg Construction Co. for $47,606.

SOUTH BEND, WASH.—Contract for construction of part of National Park highway from Frances westerly has been awarded to Allred & James, Centralia, for $9300.

SUNNYSIDE, WASH.—Contract for paving several streets has been awarded to Washington Paving Co., Smith Bdg., Seattle.

TULARE, CAL.—City clerk will receive bids until August 13 for paving 2½ miles of streets to connect with state and county highway systems. A 4-in. concrete base and ½-in. bituminous wearing surface will be used. Estimated cost is $30,000.

UPLAND, CAL.—Contract for improvement of Sixth avenue has been awarded to J. S. Menefee, Watts, at 4.95c. per sq. ft. for grading and oiling, and 24.95c. per ft. for concrete curbs.

SEWERS AND DRAINAGE

BERKELEY, CAL—Bids will be received until 10 a.m., August 10, by A. G. Briggs, city clerk, for construction of 6-in. sewer on Sacramento street.

DAVIS, CAL.—Bids will be received until August 14 at office of comptroller, University of California, Berkeley, for construction of tile-drainage system at University farm.

GRIDLEY, CAL.—Following bids were received for construction of drainage ditches for reclamation district No. 833, requiring 1,560,000 cu. yd. excavation: Kenyon & Whitman, Sacramento, $317,573.69; Ross Construction Co., $349,331.05.

HANFORD, CAL.—Bids will be received until 8 p.m., August 15, by D. C. Williams, city clerk, for removal of sewage-ejectors, and furnishing and installing two sewage-pumping units,

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DISCUSSION

Competitive Bids for Furnishing Engineering Services

The Editor:

Sir—The enclosed notice, which has come to my attention, may be of interest to you.

"Notice is hereby given that sealed proposals will be received by the Board of Supervisors of Tehama county, State of California, until Tuesday, August 14, 1917, at 10 a.m., for furnishing plans and specifications for reinforced concrete bridges over the following named creeks and an estimate cost of each bridge, to wit:

(Only approximate length of bridges given)

	Feet		Feet
Red Bank creek	250	Toomes creek	350
Elder creek	160	Mill creek	300
McClure creek	120	Antelope creek	120
Thomes creek	700	Dry creek	100
Singer creek	186		

"Also a concrete and girder subway and an estimated cost of same under the tracks of the Southern Pacific Co., about one-half mile south of Red Bluff, on the route of the state highway. The plans and specifications for each of the above named shall meet with the approval of the California Highway Commission, otherwise they will not be accepted. Not over 3% of the estimated cost shall be paid for such plans and specifications.

"The Board of Supervisors hereby reserve the right to reject any and all bids."

I understand that a provision of charter of Tehama county requires the supervisors to advertise for bids before having designs made for bridges costing more than $5000, also that the fee of 3% of the estimated cost must cover the cost of borings necessary to determine the type of foundation to be used.

This charter provision is no doubt intended to eliminate graft and to protect the taxpayers' money, but if it is followed strictly in letter and spirit it opens the way for graft that the supervisors cannot stop nor even discern.

The only way that a fair fee could be obtained for this work would be to pad the estimated cost of the bridges, a thing which, it is hardly necessary to state, no reputable engineer would do.

The probable result will be that some contractor will get the work of design and that he will later bid on the construction of the bridges. He will therefore figure on making the profit on the construction cover the deficit on making the design. Of course a contractor who has made the design for a structure has an advantage over the other contractors in bidding, and what is to prevent him from building almost any kind of a bridge from his own loosely-drawn plan, once he has been awarded the contract? The better class of contractors will not do such work, but they are not likely to be found bidding on the design.

San Francisco, July 26. E. L. Cope.

The Editor:

Sir—My attention has been called to an advertisement signed by the clerk of the Board of Supervisors of Tehama county, asking for proposals for furnishing plans, specifications, and estimates for nine reinforced-concrete bridges, of a total length of approximately 2286 ft., and a concrete and girder subway.

Common practice in the design and construction of county bridges in California has been subject to many evils. Usually, the job is given to a contractor who furnishes his own plans and guarantees the cost. Ordinarily the lowest bidder gets the job. If the contractor were always competent to design and also honest, this method might secure a good bridge at a low cost. It is, however, unnecessary to mention the many factors that enter into the case and have the opposite tendency.

The effect of the regulations of the California State Highway Commission on county-bridge building has been beneficial. Plans for bridges on any of the highways are checked for strength, and the danger from incompetent design largely obviated. This checking, however, does not attempt to cover the question of economical type and spans, and the selection of contractors. Neither have the evils of the combination of contractor and engineer been eliminated.

The method prescribed by the Tehama county charter does not hold out any hopes of improvement. In the first place it asks engineers to bid against one another for the amount of their fee. They must go to considerable expense in visiting the sites and preparing tentative plans before they can even make an intelligent bid and estimate of cost. Furthermore, the cost of the necessary borings by the 'successful' engineer is likely to amount to a large proportion of the amount of his fee. This is not an inducement to the engineer to make a careful study of foundation-conditions. Finally the Board of Supervisors may reject all bids. Doubtless, the framers of the charter thought that these provisions would assure the county of economical and suitable structures. In reality the contrary effect is more probable.

Some not over-scrupulous contractor with the aid of a cheap draftsman and the backing of some material-man will probably assume the rôle of a designing engineer, get the contract for preparing the plans and later for constructing the bridges. It will be interesting to follow later developments.

San Francisco, July 27. H. D. Dewell.

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DUG OIL-WELLS IN HIGASHIYAMA, JAPAN

As the visitor to Higashiyama ascends by a trail toward the crest of Katsubo hill, which presents a typical appearance of an up-to-date oilfield, with rigs, tanks, and boiler-houses, he will see the flank below the crest covered with conical structures resembling Indian tepees. These are huts built over dug wells.

The wells are dug by hand, the chief tools being a pick and a mattock. The earth or rock is hoisted from the hole in rope nets with a straw rope that passes over a wooden pulley hung from a beam stretched across the hut about 10 ft. above the mouth of the well. The rope is pulled by three men, two standing at the mouth of the well and the third on a shelf built in the hole about two feet below the mouth.

The hole is 4 or 5 ft. square and goes down 400 or 500 ft. to the sand without any reduction in size. The sides are timbered by driving a post in each corner to which are morticed girts to keep sheathing-boards against the wall. The girts also serve as a ladder.

The hole is ventilated by a treadle-bellows, which is a sort of bottomless box 7 ft. long by 3 ft. wide by 2 ft. deep, set on the ground at one side of the mouth of the well. The box is divided into two compartments. A tread-board covers the top of the box and balances on top of the dividing-board. A man stands on the tread-board and walks from one end to the other. In each end of the board there is a valve consisting of a square hole with a hinged flap. When one end is down, the valve on that end closes and forces the air in the compartment on that side into a small chamber attached to the outside of the box. Inside this chamber there is a tongue-valve that cuts off communication with the other compartment and allows the air to pass down an air-shaft to the bottom of the well. As the depth of the hole increases more men are set to working the bellows, sometimes as many as six.

The men generally work two-hour shifts. When the hole is making some gas or oil, a man in the bottom gets so exhausted at the end of the shift that he is literally dragged out by the rope tied to the life-belt.—*Tokyo Petroleum Times.*

Thawing frozen ground with steam from a traction-engine was tried recently at Pocatello, Idaho. The work was done when several thousand feet of 4-in. cast-iron water-pipe buried 3½ ft. below the surface was frozen during a severe winter, with an 80% loss of pipe. In order to resume service as soon as possible, a new line had to be laid while the ground was still frozen. A double line of 1½-in. pipe for the steam was laid along the line of the trench. A 300-ft. stretch was opened at a time. The ground was frozen to a depth of 4½ ft. After applying the heat for 24 hours, the ground was found to be thawed to a depth of 2½ ft. Below this, the ground was soft enough to excavate with a pick. The cost of thawing, over and above the ordinary costs of excavation, was $0.094 per foot of trench.

CONCRETE-LINED CANALS ON THE ORLAND, CALIFORNIA, PROJECT

The Orland project now has 34 miles of canals lined with concrete. The total length of canals and laterals in the distribution-system is 138, of which it is proposed to line 108 miles. It is not considered practical or economical to line the remaining 30 miles for various reasons, one of the principal being that in certain places, damage is likely to result from storm-water, making the cost of maintaining the lining unusually high.

The yearly cost of maintaining the unlined ditches is $123 per mile, and of the lined ditches $10 per mile. Seepage and evaporation losses in distributing the water over the project in unlined ditches amount to 30% of the total water turned into the canal-headgates, as against 3% in the lined ditches. The amount of storage water reaching canal-headgates from East park dam is estimated at 40,000 acre-feet. Of this amount 12,000 acre-feet is lost in unlined ditches before it reaches the land. With the proposed lining the loss will be reduced to 4000 acre-feet, effecting a saving of 8000 acre-feet per year.

HIGHWAY IMPROVEMENT REDUCES OPERATING COST OF AUTOMOBILES

The reduction in the cost of operating automobiles and other motor vehicles resulting from highway improvement is shown by an investigation which has been made with regard to automobile-travel on the highway between Austin and San Antonio, Texas. A traffic-census taken by the United States Government showed that during February there was a daily average of 931 cars passing over this road. Before the road was improved it required an average of 8 gal. of gasoline for the trip. This has been reduced to 5 gal. At 22c. per gal. this would give a saving of $221,205.60 in one year. The estimated saving on lubricating-oil was $20,000, and on tires, $127,000, bringing the total saving on the three items to $368,205.60 for the year. The cost of constructing the road was $239,800. The saving in one year, therefore, was $128,405.60 more than the cost of the road.

Bond sales reported by California counties for the fiscal years 1912 to 1916 amounted to $41,738,503.27 for county bonds alone. In addition $25,397,144.82 worth of district bonds were sold, mainly for school-districts, giving a total of $67,035,648.09. This does not include bonds sold by the city and county of San Francisco for the fiscal year 1916. The sales by years were as follows: 1912, county bonds, $7,240,932.01; district bonds, $5,415,306.61; total, $12,656,237.62. 1913, county bonds, $13,723,303.13; district bonds, $3,859,614.66; total, $17,562,917.79. 1914, county bonds, $10,180,121.11; district bonds, $4,279,367.12; total, $14,459,488.23. 1915, county bonds, $7,106,714.06; district bonds, $6,928,810.94; total, $13,035,525. 1916, county bonds, $3,487,432.96; district bonds, $5,814,046.49; total, $9,301,479.45.

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Methods and Costs of Construction of the Shoal Lake Dike

By H. L. TILLEY*

In the April and October numbers of WESTERN ENGINEERING, I gave a description of the construction of the 100-mile concrete pipe-line for the Greater Winnipeg water district. The present deals with the construction of a dike at Shoal lake, the intake of the aqueduct. The object of the dike is to divert the impure water of Falcon river from the intake. The average depth of the water at this point is 12 ft. and the dike is about a mile long.

The principal factor affecting the probable cost of the work to the contractor, and therefore the bidding prices, was the method used for getting the material in place. The estimate of the consulting engineer for the district was based on the assumption that a timber trestle would be constructed supporting a 'dinky-train' track for the entire length of the dike. He estimated the cost of this trestle at $35,000. As will be seen from the summary below, five bidders figured fairly close to the engineer's estimate.

The low bidder, who was awarded the contract, substituted for the $35,000 trestle a pontoon composed of a couple of old barges and a few pieces of heavy timber, the total cost being less than $6000. Fig. 1 and 2 show two views of the pontoon and the train delivering material at the end of the dike. The main barge was 24 by 80 ft. Timber stringers 18 ft. long served as a bridge for the 'dinky-track' from the end of the completed dump to the barge. As shown in the figures, the barge was held stationary by spuds of the usual type.

Stringers 8 by 10 in. by 18 ft. extended for the full length of the barge and carried cribbing on which the 'dinky-track' rested. The cribbing was required in order to bring the 'dinky-track' to the required elevation for the finished dike. The stringers rested on wooden rollers which rolled directly on the floor of the barge.

When the dump was finished to the end of the barge, the following procedure was required in order to move ahead. A $\frac{5}{8}$-in. cable was kept fastened to the barge at the point nearest to the dump, extending over a sheave that was fastened at the end of the timber skids at the point farthest from the dump. When a move was required, the cable was brought back over the track and fastened to the 'dinky-train.' The spuds were then lifted

SUMMARY OF BIDS

Item and quantity	(1)	(1)	(3)	(4)	(5)	(6)	Est.
Stripping, 7000 cu. yd.	$0.30	$0.75	$0.65	$0.60	$0.25	$0.43	....
Material in dike, 233,100 cu. yd.	0.2775	0.40	0.40	0.40	0.461	0.43	0.45
Top dressing, 5200 cu. yd.	0.50	0.80	1.00	0.90	0.50	1.00	....
Riprap on slope, 10,300 cu. yd.	2.40	2.00	2.50	2.50	2.00	3.25	1.50
Material loaded on cars, 5000 cu. yd.	0.30	0.25	0.20	0.40	0.30	0.20	....
Material reserved, 2000 cu. yd.	0.30	0.50	0.30	0.40	0.45	0.43	....

The total of the bids was as follows: No. 1, $96,205.50; No. 2, $125,500; No. 3, $130,340; No. 4, $130,670; No. 5, $134,576; No. 6, $143,778; engineer's estimate (after making allowances), $130,309.

*3753 Lincoln avenue, Oakland, California.

TABLE I. LABOR DISTRIBUTION

Falcon River Diversion Dyke, Record of Labor, Distribution and Cost.

Month.	Supervision.		Unloading. Plant Constr'n. Buildings.		Stripping		Dyke.		Rip-rap.		Top Dressing.		Cleaning Up.		Totals.	
1914.	Man Days.	Amount.	Man Days.	Amount.	Man Days.	Amount.	Man Days.	Amount.	Man Days.	Amount.	Man Days.	Amount.	Man Days.	Amount.	Man Days.	Amount.
June.	81	$532.00	438	$1154.00	219	$436.75	809	$1998.50		$		$		$	1547	$4121.25
July.	81	540.00	175	561.50	71	141.25	1657	4148.00	661	1606.50					2645	6997.25
August.	81	540.00	43	86.00			1641	4174.00	809	2065.50					2574	6865.50
September.	71.7	494.80	8	44.00			1543.7	3820.80	745	1931.00					2368.4	6290.60
October.	73.2	508.80	42	97.50	76	173.00	1387.2	3543.05	730	1927.50					2308.4	6249.85
November.	67.9	471.60					773.7	1680.45	643	1733.00					1484.6	3885.05
December.	27	108.00							541	1465.75					568	1573.75
1915.																
May.	58	340.00	30.7	61.40			650	1648.35	45.5	91.00	598.8	1414.25			1383	3555.00
June.	28	216.00							2	4.00	140	334.50	82	195.50	252	750.00
Totals.	568.8	3751.20	736.7	2004.40	366	751.00	8461.6	21013.15	4176.5	10824.25	738.8	1748.75	82	195.50	15130.4	40288.25

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and the 'dinky' pulled on the cable. The barge then moved out under the rollers, leaving a gap between the end of the dump and the barge ready to be filled from the 'dinky-train.' Another section of timber cribbing and track was laid preparatory to the next move.

A small barge was used ahead for carrying extra sections of cribbing and track, so as to provide additional track in case of delays in dumping after a move was made. Fig. 3 shows the steam-shovel, which was a model 60, 2½-yd. Marion, loading a 'dinky-train' at the pit. The distance from the pit to the beginning of the fill was 1500 feet.

The 'dinky-engines' used weighed 27 tons and they pulled four-yard Western side-dumping cars. The track

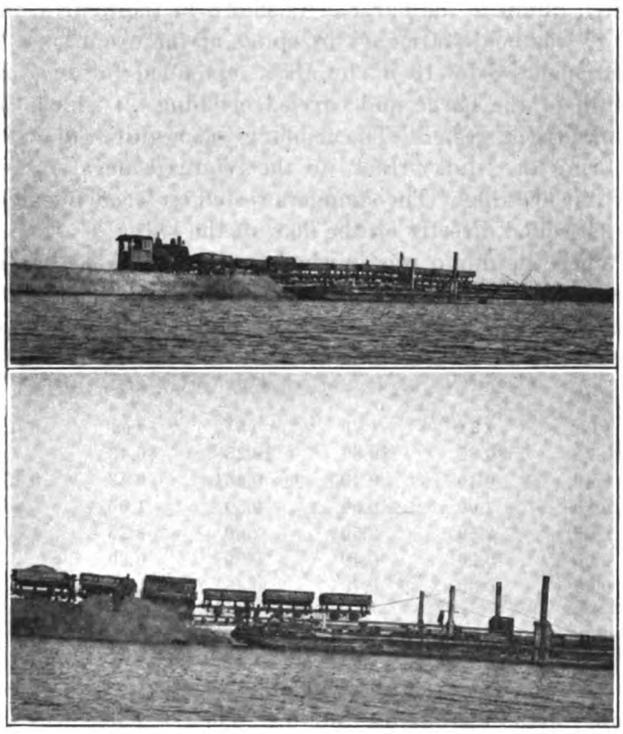

FIG. 1 AND 2. TWO BARGES AND DINKY TRAIN AND NEARER VIEW OF THE LARGER BARGE

was 3-ft. gauge and was composed of 100 tons of 60-lb. and 8 tons of 80-lb. rails that happened to be on hand. The entire plant and supplies were floated across the Lake of the Woods, 60 miles, from Kenore on the Canadian Pacific railroad.

The scale of wages was as follows, all rates being per day:

Superintendent	$8.00	Cranesman	4.00
Bookkeeper	4.00	Locomotive drivers	4.00
Foreman of carpenters	5.50	Firemen	3.00
Foreman of laborers	3.50	Brakemen	3.00
Carpenters	3.50	Blacksmith	3.50
Laborers	2.00	Pumpman	2.50
Team and driver	5.50	Powdermen	3.50
Horses	$1.75	Drillers	2.50
Steam shovel runner	7.00		

The labor distribution is shown in Table I.

Table II shows the equipment rentals.

TABLE II

Item	Rate per day	Days	Amount
Steam-shovel	$20.00	119.7	$2,394.00
Engine	10.00	324	3,240.00
Cars	1.00	3,511	3,511.00
Barge	6.00	114	684.00
Pumps and boiler	2.00	121.7	243.40
Track	15.00*	95	1,425.00
Track	10.00*	38	380.00
Small equipment	10.00	141	1,410.00
Small barge	2.00	89	178.00
Drill-steel	3.00	129	387.00
Cars for riprap	0.50	620	310.00
Track for riprap	2.00	129	258.00
Small equipment for riprap	1.00	129	129.00
Total equipment-rental			$14,549.00

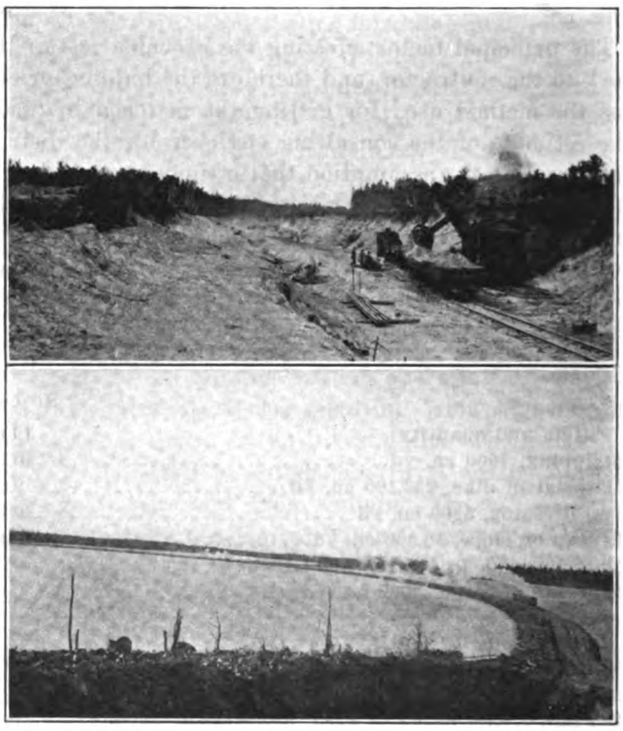

FIG. 3 AND 4. STEAM-SHOVEL IN PIT AND DIKE DURING CONSTRUCTION

*For track up to one mile, $10 per day was allowed. For track from 1 to 1½ miles, $15 per day was allowed.

Coal cost $8 per ton. About 2000 cu. yd. car measurement and 2500 cu. yd. embankment measurement was placed per month. The approximate cost to the contractor for the entire work was as follows:

Labor	$40,288.25
Equipment-rental	14,549.40
Moving plant	6,000.00
Coal	2,080.00
Total	$62,897.65

The final payment to the contractor was made on the basis of the following quantities: 1397 cu. yd. stripping, 213,115 cu. yd. material in dike, 5471 cu. yd. top-dressing, and 9856 cu. yd. riprap, giving a payment of $85,902.06, indicating a substantial profit in spite of the bid being lower than the other estimates.

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The Importance of Inspection of Paving Materials

By CARL F. ADAM*

A little over a year ago a big jobbing-house in London opened negotiations with a Californian refiner with a view to the introduction on a large scale of Californian asphalts in the paving and roofing industries throughout England. A full line of samples was shipped to the jobber and by him submitted for tests to a prominent English chemist. His investigation was elaborate, including even ultimate analyses; his report was lengthy; no doubt his fee was proportionately large. Sad to say, few of the chemical tests and not a single physical test had been performed according to accepted methods of procedure, not one reported result was a correct finding, and not one conclusion was of the slightest practical value to anyone. Several well-known and most revealing physical tests had not been performed at all. This sounds like an exaggerated indictment, but I can assure the reader the case is not overstated. If I had not been privileged to review this remarkable report I should never have believed it possible. Nothing in my experience with testing-laboratories has ever exposed so clearly the danger of entrusting the inspection of paving materials to a chemist simply because he is a chemist: or to an assayer for no better reason.

Except in degree, the foregoing is by no means an isolated case. A few years ago the official chemist employed by a city in Iowa, through ignorance of the care required in order to prepare samples of asphalt for the comparatively simple test of penetration, reached a series of mistaken conclusions which caused the city officials to stop the work of the paving-contractor who had submitted the samples. Before the matter could be adjusted, work on the street had been delayed two weeks or more, the disorganization of the contractor's forces had put him to considerable financial loss, the producer of the asphalt in question had sent me half-way across the continent to straighten out the city chemist, and the city itself had been laid open to an action for damages.

In a more recent instance a chemist with no paving experience was engaged 'for the job' as asphalt inspector for a Californian city. Toward the close of the work the surface of the pavement under construction developed a number of small cracks. The chemist made a few perfunctory tests whose results he was unable to interpret, rendered an erroneous decision concerning the cause of the cracking, and proceeded to tie up a completed contract for a pavement costing a large sum of money. The primary cause of the whole trouble was an effort to economize by allowing a well-meaning but inexperienced city official to handle the inspection and control the mixtures. The contractor had faithfully performed his work in strict accordance with instructions from the inspector, though at needless cost for excess materials used, but for nearly two months he was denied formal acceptance of the work. The material-men could not collect from the contractor, and the city, leaning on two broken reeds, narrowly escaped a number of lawsuits. Eventually, in both these cases, the chemists admitted their incompetence before any legal action had been taken, but not in time to prevent costly delays and needless outlay of money.

It would be folly to contend that the history of these cases shows the contractors and material-men as the only losers. Aside from the uncalled-for annoyances that must surely be suffered by merchants and property-owners through avoidable delays in the work of paving a street, the fact remains that the public pays in the end for all wastes such as the above. The contractor must pay a higher price for the materials of construction and the property-owner, or the city, must pay more for the pavement.

Often the heaviest loss of all appears only after the lapse of considerable time during which the pavement has been subjected to the one supreme test, that of service. The results of incompetent inspection may remain hidden for awhile, but 'murder will out,' and it is not unusual in such cases to find the pavement in need of extensive repairs within a year after it was laid. One instance of this kind occurred in a Pacific Coast city, where, through inexperience and lack of adequate technical inspection, a sheet-asphalt surface of considerable area developed serious defects in about six months and had to be replaced entirely in less than two years. The cost of re-surfacing was in the neighborhood of forty thousand dollars. Fortunately, in this case the city was safeguarded by a maintenance contract, a plan which is disapproved by the Supreme Court of California. The merchants, however, on both sides of this street were in no wise protected against repeated annoyances resulting from frequent patching and final re-surfacing of the work. Somebody had to pay heavily for the blunder. If in this case the original contractor, or else his bondsman, appears to be the chief sufferer, make no mistake, he surely tried his best to make someone else suffer in like fashion at the first opportunity. In California we lack even the protection of a maintenance bond to insure our peace of mind. How much more essential, then, to adopt a sane course in the planning of the work and in the employment of inspectors.

True economy lies not in the penny-wise policy of engaging at low rates a chemist with limited experience in paving inspection. Yet this is being done again and again by city officials in the mistaken belief that they thereby save the property-owner a few dollars. Com-

*Consulting engineer, 2653 Menlo avenue, Los Angeles.

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petent inspection is a vital necessity on any class of engineering work, and paving is no exception. Particularly in the inspection of the materials entering into the wearing surface of a pavement there are involved so many special technical as well as practical details that few engineers have either the time or the training required to handle them. That is why it is highly advisable, both before and during the construction of a pavement, to place the business of selecting and inspecting the materials, mixtures, etc., in the hands of a trained specialist. It is the only way to make sure of getting full value for the money invested in the pavement. It is not enough to hand your material-samples to a general chemist or assayer with instructions to analyze or test them. Be the man ever so skilled in his own particular line, ever so painstaking and accurate in his analyses; unless he has had experience and training in the paving field itself, his inspection will be of no constructive value whatever. To be sure, some chemists without knowledge of paving may be able to make all the required tests in approved manner. Their results may be entirely correct and their determinations show clearly whether materials and mixtures do or do not comply with the requirements of the specifications; but that, too, is far from enough. As shown in a previous article on 'Specifications',† there are many important details in connection with the construction of sheet-asphalt and asphalt-concrete pavements upon which the specifications are necessarily silent, because materials will vary in quality and character, making it impossible to prescribe exact proportions. It is manifest, therefore, that the man who is required to inspect the materials and prescribe and pass on the mixtures should know more about paving than the text-books and specifications can tell him.

Often during the construction of a sheet-asphalt or asphalt-concrete pavement, for instance, a sudden and unforeseen change in the character of the sand-supply will manifest itself in some peculiar behavior of the freshly-laid surface. The cause must be found immediately, and, unless the inspection is in the hands of an expert, costly delays are almost sure to follow. The application of the necessary corrective measures is usually beyond the ability of any but a trained observer. The sieve-tests of the sand show that the sand still complies with the specifications; the dust being used is still from the original approved shipment; what is the trouble? In ninety-nine cases out of a hundred the inexperienced inspector will ascribe it to some fancied peculiarity or imaginary defect in the asphalt. In fact this is also a popular custom. Let the pavement develop unsightly cracks and the favorite criticism is that the asphalt is at fault. 'It is too hard, or something.' Let the surface be marred so badly in warm weather than not only horses but vehicles, too, will stand 'without hitching,' and they say 'the asphalt-cement is too soft.' Let the surface show signs of 'alligatoring', and the verdict may be (as it actually was in a Californian city not long ago), 'there is too much sulphur in the asphalt.'

†WESTERN ENGINEERING, Vol. VIII, p. 230.

Now, in none of these examples is the assumed cause likely to have any foundation in fact. In the case of cracking pavements the fault may be entirely in the character of the sand used in the surface mixture, or the mixture may be perfect and yet show cracks because of a defective base. Sometimes the character of the subgrade is the primary cause of the whole trouble. Soft pavements, and pavements that 'alligator,' are usually the result of defective or peculiar grading of the mineral aggregate, especially the finer sands and dust, or to the use of an excessive amount of asphalt, more than the sand will 'carry.' It is a fact that the success or failure of an asphalt surface rests most often upon the proper selection and use of the ingredients whose examination is popularly supposed to be the least mysterious. Sand is such a plain, common, every-day affair. We all know what sand is. But asphalt! That heterogeneous mixture of hydro-carbons of various series obtained from a material of unknown origin! If anything goes wrong the trouble must be with the asphalt. It should not require the application of any stupendous mental processes to recognize that there are two significant reasons why, as between asphalt and sand, the former is the less likely to cause trouble through defects in quality. The first is that, weight for weight, a sheet-asphalt surface will contain usually about eight times as much sand as asphalt, and an asphalt concrete from three to six times as much. The second is that the asphalt, purchased presumably from a reliable refiner, was made purposely for use in paving and passed laboratory-inspection before it was shipped, while the sand was deposited, so far as we can tell, with no thought of its use for paving, with little regard to uniformity and without laboratory inspection.

This does not mean that the examination of the asphalt becomes superfluous at any stage of the work. For the sake of his own reputation the contractor should and usually does check the penetration of each batch as it is received from the refiner, even though the material is guaranteed to meet the specifications under which the work is being laid. Some contractors maintain complete control-laboratories for the constant supervision of all materials of construction. Nevertheless, accidents may happen. A little forgetfulness or lack of care on the part of the paving-yard force may at any time result in hardening the asphalt to such an extent that by the time it is ready for the mixer, or sometimes after it has come in contact with overheated aggregate in the mixer, it no longer complies with the specifications and may, in fact, be entirely unfit for use in the pavement. The duty of city officials to protect the property-owner against the almost certain consequences of such mishaps cannot be questioned. Of course the reliable contractor will not permit material known to have been injured by overheating, or otherwise, to enter the construction, but the injury may not be known to him in time to prevent its use. Unless the oversight is disclosed by city inspection and the defective work immedately replaced by good material it is but human nature for the contractor to risk its passing unnoticed until after acceptance of the work

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and collection of the final assessment. This condition is most likely to arise on minor jobs, work in small cities situated at some distance from the contractor's main laboratory, or on contracts where the bidding has been unusually close. On such work, then, it becomes all the more imperative to provide competent and thorough inspection at the yard, on the street, and in the laboratory.

While the foregoing discussion relates in the main to a specific class of pavements, the same general procedure is desirable in the case of other types. Portland cement, crushed stone, liquid asphalt ('road-oil'), vitrified brick, concrete-sand, or any other paving material varies in character and quality from day to day, from batch to batch. Few natural deposits are noted for their uniformity. To the ordinary variations in a crude material must be added the known irregularities in atmospheric and other conditions surrounding the manufacture of such products as portland cement, asphalt, road-oil, or vitrified brick, and it is not surprising that constant watchfulness by experts is required to achieve even a reasonable approximation to uniformity in the finished material. By combining large quantities, or successive daily runs, of asphalt or of cement a sort of average quality may be struck and practical uniformity be secured after the manufacturing process has been completed. This method is not applicable in the case of vitrified brick. Each block must be judged by its individual characteristics. One underburned brick in the wearing surface will start a hole that may spread over many square yards of properly burned brick surrounding it. In standard practice it is usual to test in the rattler only one brick out of a thousand or more and therefore the visual inspection of an expert on the job must supplement the laboratory tests in order to secure satisfactory work.

The cost of competent inspection will vary, of course, with the size and nature of the work, but on asphalt, brick, and concrete pavements will rarely exceed 3% of the contract price except on unusually small jobs. On work covering a large area the cost ordinarily should not exceed 2%. This includes yard, street, and laboratory inspection of the entire work, including foundation-base, and wearing surface. Provided the specifications have been reasonably drawn and no unusual difficulty arises during the course of the work the cost of the necessary chemical and physical tests of the materials will amount to a relatively small proportion, usually less than a quarter, of the total cost of inspection. In view of the foregoing facts it is surely poor economy to jeopardize the success of the whole pavement by perfunctory inspection of work or by entrusting the testing of materials to other than trained specialists.

A portable signal-projector has been adopted by the U. S. Coast Guard Service. It consists of a 6-volt, 1½-ampere, 12 candle-power, mazda lamp operated by four ordinary dry cells, an 11-in. glass parabolic mirror, and a container for the two, equipped with a telegraph key for making and breaking the circuit.

USE OF AUTOMOBILES IN THE MANAGEMENT OF A RECLAMATION SERVICE PROJECT

A recent number of the *Reclamation Record* contains an article on the use of automobiles on the Belle Fourche project, South Dakota, by B. E. Hayden, project manager. Three cars are used, two 5-passenger and one 2-passenger. During 1911 an automobile was purchased for the use of the project manager, and was found to be both convenient and economical. In 1915 the irrigation manager's team was replaced with an automobile, and in 1916 it was found expedient to use an automobile in making drainage surveys and investigations over a scattered area. Even over bad roads it has been found that the lighter cars make better time than driving-teams. When necessary to make trips over very bad roads a light work-team will make better progress than a driving-team, so that it has been found unnecessary to keep extra driving-teams to replace the automobiles when roads are bad.

Some of the costs for operating automobiles on this project are given below:

	Machine		
	No. 1	No. 2	No. 3
Horse-power	30	20	20
Passengers	5	5	5
Date purchased..	June 13, 1911	Aug. 21, 1915	Nov. 11, 1916
Cost f.o.b. Newell, South Dakota..	$1200	$502.26	$405
Present condition	Sold Dec. 16, 1916	Good	Excellent
Miles operated...	15,900	8593	350
Cost per mile, including depreciation	$0.157	$0.080	$0.066
Miles per gallon of gasoline....	10	15	17
Miles per gallon of lubricating oil	191	192	

Assuming that the period of usefulness of a driving-team when used continuously as such is 5 years and that during this period it would travel 15,600 miles (an average of 10 miles per working-day), the cost per mile, based upon the corral-cost for this project, would be $0.176 per mile. This cost compares fairly well with that of machine No. 1, but is about twice as much as the cost to date of machines No. 2 and 3. The first cost of machine No. 2 or No. 3 is considerably less than that of a good team, buggy, and harness; the operating cost is about half as much; and the efficiency, in point of time, is more than double that of the team. On an average, a team will travel 6 miles per hour, as against 16 miles for an automobile. Therefore in traveling the 15,600 miles assumed to be the life of a team, a saving of 1560 hours, or 195 eight-hour days, will result from the use of the automobile.

While not expressly stated in the article, it would seem probable that the sale of the $1200 machine and the substitution of a 2-passenger car was influenced at least by the relatively high cost per mile of the first machine.

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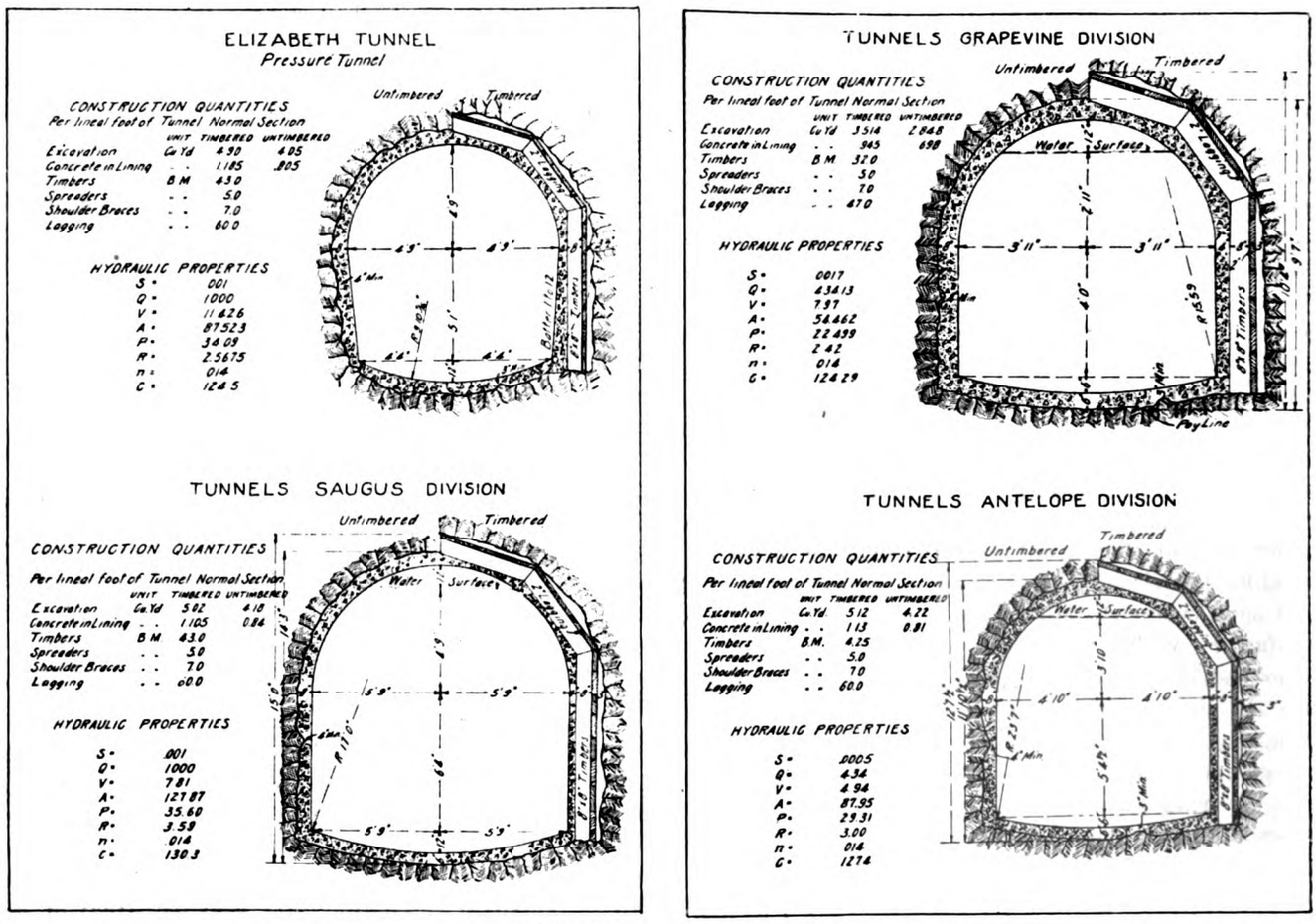
Costs of Construction of Tunnels on Los Angeles Aqueduct

In view of the forthcoming award of contracts for about $6,000,000 worth of tunnel work in connection with the Hetch-Hetchy water-supply project, the following summary of costs of similar tunnels on the Los Angeles aqueduct, taken from the report of John R. Freeman regarding the Hetch-Hetchy project, is of interest. The standard sections for the aqueduct work are shown below.

Bids for the Hetch-Hetchy tunnels are to be received by the Board of Public Works of San Francisco until August 22. The tunnels are on the mountain division of the aquedust, and the total length is 18 miles. The tunnels are to be of horseshoe section, lined with concrete, and both the height and the width inside the concrete lining is to be 10 ft. 3 in. Practically all the material is granite. The work is divided into three sections and contractors will be allowed to bid on one or all of the sections.



STANDARD SECTIONS FOR LOS ANGELES AQUEDUCT TUNNELS

BRAKING EFFICIENCY ON MOTOR TRUCKS

A test of the braking efficiency of the 3½-ton U. S. motor-truck was made recently on Madison avenue, Covington, Kentucky, by E. C. Shumard, engineer, and E. S. Lee, Jr., advertising manager for the United States Motor Truck Co. Three trials were made of stopping the truck in the shortest possible space after it had reached a speed of 13 miles per hour.

In the first case the total net load on the truck was 9000 lb. When the truck had reached its full speed of 13 miles per hour, the driver stopped the motor and set both brakes. The wheels stopped revolving instantly and slid along the pavement, bringing the truck to a full stop in 18 feet.

This was repeated with half a load and the truck stopped in 19 ft. Then the trial was made with the empty truck. The brakes set firmly as before and the result was that the truck without the load failed to stick to the pavement and progressed for 24 ft. in a series of rapid jumps, leaving the ground about every three feet.

A metric system of street-numbering is used in Pernambuco, Brazil. For example, the number of a house 134 metres from a certain starting-point is 134.

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COST OF TUNNELS ON LOS ANGELES AQUEDUCT

Data, Monthly Reports to Chief Engineer on 80 Headings, 24 Miles of Tunnel in Widely Different Formation

Condensed by J.R.F. June, 1912. E.R.O.E.

KIND OF ROCK (The most Costly at Top)	Number of Tunnel	Net AREA of Tunnel Cross Section Sq. Ft.	TIMBERING % of Length Timbered	TIMBERING Cost per Timbered Foot	TIMBERING Cost per Excavated Foot	EXCAVATION and Mucking incl. Trimming to Grade & Cleaning: Cu. Yds. per Ft. to Prescribed Line	EXCAVATION: Cost per Cubic Yard	EXCAVATION: Cost per Lineal Foot	CONCRETE LINING incl. Plastering: Cu. Yds. per Ft. Theoretically needed	CONCRETE LINING: Cost per Theoretic Cubic Yard	CONCRETE LINING: Cost per Lineal Foot	All Other Misc. Costs per Foot	TOTAL COST per Lineal Foot
Hard Granite. Some Very Hard Syenite	13	58	4	3.13	.14	2.88	8.72	25.07	.71	8.81	6.26	3.66	35.13
Hard Granite	15	"	0			2.85	8.45	24.05	.70	7.36	5.15	5.64	34.84
" "	14	"	4	4.67	.16	2.87	8.29	23.74	.71	7.60	5.39	3.96	33.25
" "	17-A,B	"	5	7.28	.34	2.88	7.69	22.14	.71	8.59	(6.09)	3.25	31.82
" "	16	"	1	4.97	.04	2.86	7.49	21.41	.70	7.78	5.44	3.81	30.70
" "	39	63	48	3.58	1.72	3.38	5.34	18.05	.84	8.85	(7.43)	3.27	30.47
" "	P 2-5	97	3	4.10	.11	4.47	4.99	22.30	.89	10.44	(9.30)	3.38	35.09
Elizabeth Lake Granite; Sound Dry South; Broken Wet North	72	88	61	8.74	5.35	4.69	6.75	31.71	1.00	11.03	11.03	4.90	52.99
Hard Granite with a Few Slips	12	58	4	3.58	.14	2.88	7.25	20.84	.71	7.88	(5.59)	3.81	30.38
" " " " "	17	"	7	3.95	.29	2.90	6.14	17.79	.72	8.46	(6.09)	3.16	27.33
Granite, Blocky, Very Wet, Treacherous	35	63	48	4.68	2.25	3.38	5.45	18.41	.84	10.37	8.72	3.20	32.58
" " " " "	38	"	74	5.62	4.18	3.58	5.07	18.06	.91	10.90	9.92	3.33	35.49
Granite, Hard, Blocky	4	58	80	2.54	2.03	3.38	3.89	13.13	.90	9.01	(8.11)	3.52	26.79
Granite, Faulty, Decomposed	8	"	26	5.92	1.53	3.03	4.95	15.00	.76	10.92	8.30	3.70	28.53
Granite with bad Flow Carbonic Gash Talcose Slips - Wet Ground	3	"	88	4.12	3.64	3.43	3.96	13.58	.92	9.02	8.30	3.63	29.15
Granite, Faulty, Decomposed	29,31-33	63	47	2.18	1.02	3.37	4.03	13.57	.84	10.76	9.04	3.30	26.93
" " "	27,28	"	38	2.73	1.05	3.31	4.00	13.22	.82	8.37	6.86	3.33	24.46
Biotite Granite Oblique bands of Harder Rock than in No. 3	7	58	86	3.39	2.92	3.42	3.85	13.15	.91	8.91	(8.11)	3.39	27.57
Decomposed Granite & Porphyry	43	63	67	.97	.65	3.51	3.34	11.71	.89	8.12	(7.22)	3.25	22.83
Decomposed Granite, Homogeneous	42	"	32	1.28	.41	3.26	3.48	11.33	.80	5.48	4.38	3.25	19.37
Decomposed Granite	46	"	43	2.60	1.13	3.34	3.22	10.75	.83	6.76	5.61	3.16	20.65
Medium Granite	2,2-A	58	95	3.26	3.10	3.48	2.47	8.62	.93	8.28	7.70	3.74	23.16
Granite, Soft, Broken	1,1-A,B	"	42	1.87	.78	3.12	2.52	7.89	.80	10.13	(8.11)	3.63	20.41
No. Half - Slate, Hard, Broken, Disturbed So. Half - Sound, Cost very much less than No.	73	132	86	7.31	6.27	6.58	4.21	27.70	1.27	8.67	(11.00)	3.32	48.29
Slate and Schist	P 10-14	97	79	7.23	5.72	5.17	3.38	17.47	1.10	8.90	(9.80)	3.34	36.33
Quicksand and Caving Ground	104	92	98	5.41	5.29	5.10	3.46	17.65	1.12	7.50	8.40	3.26	34.60
Sandstone	P 8,9	97	71	7.81	6.55	5.10	3.59	18.29	1.07	9.16	(9.80)	3.31	37.94
Incipient Sandstone, Dry Holds record for Progress, 1063 ft. in 30 days	17-M	79	19	1.56	.29	3.85	2.06	7.96	.83	7.35	(6.10)	3.00	17.35
Compact Sand Gravel and Clay	77	132	70	5.47	3.84	6.48	3.00	19.42	1.23	7.32	9.01	3.61	35.88
" " " "	75,76	"	40	3.34	1.33	6.23	2.67	16.62	1.14	6.89	7.86	3.39	29.20
" " " "	93	92	78	2.99	2.32	4.92	2.26	11.14	1.06	8.02	(8.50)	3.23	25.19
" " " "	94-96	"	100	3.85	3.85	5.12	2.03	10.37	1.13	7.52	(8.50)	3.18	25.90
" " " "	78,79	"	3	2.07	.06	4.25	2.03	8.66	.82	9.76	(8.00)	3.19	19.91
" " " "	100-102	"	100	3.62	3.62	5.12	1.80	9.25	1.13	5.55	6.27	3.36	22.50
" " " "	82,84,85	"	88	1.60	1.40	5.01	1.78	8.94	1.09	7.80	(8.50)	3.25	22.09
" " " "	89	"	100	1.38	1.38	5.12	1.49	7.62	1.13	9.43	10.65	3.23	22.88

To the Total Cost given in last column, additions must be made for General Expense at City Headquarters, General Engineering Design and Preliminary Surveys and Bench Levels. Also add for Roads and Trails about $1.00 per foot, variable on different Divisions of the Work. Also add for Heavy Movable Plant - Rails, Locomotives, Pumps, etc. - say $1.50 per ft. here on L.A. Aqueduct, including repeated use and deducting salvage. Minor Equipment, Temporary Power Plants and cost of Electric Power are included in the Tabulated Costs. The work was done by day labor under exceptionally good management. Hence allow for Contractor's Profit, Ordinary Management and Adverse Labor Conditions.

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DATA ON COST OF TUNNELS ON LOS ANGELES AQUEDUCT

80 Headings, 24 Miles, Widely different formations

Condensed from Monthly Reports to Chief Engineer (by J.R.F., June, 1912. E.&O.E. Subject to Revision.)

| General Character of Rock | GRANITE | | |

Outlook for Iron and Steel on the Pacific Coast

By ERNEST A. HERSAM

Whether or not the Pacific Coast states can profitably produce iron and steel from the ore, or can develop later an extensive iron industry, is a question that demands an answer. If the industry is practicable, steps to promote it are important and should be encouraged. If there are qualifications or limitations to iron smelting in the West, the people ought to know of it. To consider the possibility of developing an extensive iron and steel industry through the actual smelting of iron ore, leads to some fundamental scientific and economic considerations. It is an easy matter to define the requirements of iron manufacture as represented in present practice, and to observe whether or not these can conform to given local conditions in future practice. It appears at once to be extraordinary that the iron ores of the West Coast have not contributed more abundantly toward the iron-output of the United States, yet the Pacific-Coast States are importing from the East and from abroad practically all of the iron used by them in local construction and manufacture. This backwardness is seen to limit the local expansion of manufacturing industry, dependent as it is upon pig-iron and the iron and steel products derived from pig-iron.

In the ordinary process of iron and steel manufacture the mills and foundries designed to supply the metal in the forms required in commerce are based upon supplies of pig-iron that are easily accessible in ample quantity. Without such an abundant supply of pig-iron, no well-developed and extensive manufacturing industry can exist. Foundries and rolling-mills that rely on distant sources, produce only with difficulty and at high cost, and the manufacture of small articles, machinery, and varied appliances, in which iron and steel are essential, is monopolized by districts favorably situated.

As a fundamental commodity pig-iron ranks with timber, food, and fuel; and these elements of the commercial world are the determinants of industrial growth, as are air, water, and sunlight of human life. An available supply of iron indicates that a region will become densely populated, that the harbors will be crowded with shipping and that great cities will be built. The industries on the western coast of the United States, that started from resources other than iron, and have grown despite the absence of a local iron-supply, have remained at the limit set by the local cost of iron and steel.

There are some who hope for an abundant supply of Californian pig-iron in the near future, at a price not higher than that prevailing in the iron regions of the East. Others believe that the Pacific Coast does not possess the essentials for a self-supporting iron-industry, and that no relief from the high prices would result even if local production were attempted. A potential supply of iron does not consist solely in the presence of the ore, but requires also a fuel such as can be used to smelt it. The economic tendency of the iron-industry, the world over, is toward centralization, and is opposed by the extension of iron-production to the West. Though there are ores, and oil, and electric power, and markets on the Pacific Coast, similarly there are hundreds of millions of tons of unmined ore available in the densely peopled states of the East, but remaining unused because of cheaper ore 1000 miles distant.

The ore resources of the Pacific Coast appear to warrant the development of an iron-smelting industry. The hematite deposits of Eagle mountain, in southern California, have been shown to be ample for operating a blast-furnace for 200 years. Some of this ore is pronounced to be of the finest quality. Much is judged to be capable of being enriched by sorting. Shasta county, in California, is also capable of supplying iron ore for an important industry. In Madera county, California, there is a body of ore estimated at 50 to 100 million tons of good quality. Elsewhere, as in San Bernardino county, in the Kingston mountains, and also in Oregon and Washington, there is ore said to be suitable in quality and amount for smelting operations. While the deposits of iron ore on the western coast are small compared with the great reserves in the East and in the Lake Superior region, they are adequate, so far as the ore is concerned, to meet the local demand, and are worthy of attention. In recent years the extensive deposits of black-sand, which abounds on the Pacific Coast and elsewhere, has been looked to as an attractive source of iron. These sands are known to contain, amongst other minerals, a small proportion of magnetite. While there is little possibility of using widely scattered material of this character for extensive iron-manufacture, yet the improvements in separation and the demand for the contained minerals, other than the magnetite, suggest using the material for iron or steel-manufacture in a small way. The backwardness of the iron-industry in the West is the direct outcome of the economy of production in the East; and it is the relative cheapness of the Eastern supply that renders the western condition tolerable. Moreover the demand for iron and steel in the West covers a wide variety of forms; and plants to supply the Western needs are called upon to furnish shapes difficult to produce at any single establishment. The local consumers would be limited if made dependent upon a local supply. A single blast-furnace would fail to supply the varied demand for local consumption. The limitation, however, that is most serious to production in the West is the absence of fuel of the

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kind commonly required in iron smelting. To obviate the cost of transportation of coke there arise the problems of novel metallurgical methods utilizing the heat-energy that locally can be had.

The sources of coke available in the West are those from China or abroad, the development of the coking coals of Alaska, the coke of Utah and Colorado, and finally there arises the question of adaptation of practice to permit of employing coke that can be made from the coals of Washington. There remains the possible substitution of other fuels for the needed coke. The production of a satisfactory coke has been claimed to be possible as a by-product from petroleum, when treated by a special process in gas manufacture, with this end in view. Commercial demonstration of the possibility of doing this, however, is as yet wanting. The use of natural oil, with regenerative appliances, is possible, but only under important limitations and with diminished heat-efficiency. California, which is one of the most productive oil fields of the world, would be in a position to profit by the use of its natural resources in this way. The use of electric energy in iron-smelting has been demonstrated as not only possible, but practicable, under certain limitations. In this particular the West, possessing available water-power in the Sierra Nevada and the Cascade ranges, offers a cost comparing favorably with such power elsewhere, and is in a position to profit by this extension of the industry.

The treatment of iron ores, by the standard processes, is an industry involving large tonnages and broad markets, while the mining, transportation, and smelting are circumscribed by the low value for a given weight. The average value of iron ore, such as is now derived from the Lake Superior region, or from Cuba, Spain, Canada, and elsewhere, is normally about $3 per ton at seaboard, or at the smelting-centers. The cost of the ore at the mine may be rated at 50c. to $1 per ton. The cost of ore, at $3, at the Eastern smelting-centers consists, therefore, largely in the cost of transportation, which commonly amounts to two or three times the cost of mining. The handling and transportation of large tonnages of iron ore of this relatively low value calls for accessibility, either through natural ways of transportation or the actual proximity of the ore to regions where the metal is consumed. The average value of coke at tidewater, for example, at Baltimore, may be taken as normally about $2.50 per ton. Coke in the State of Washington costs twice this amount. Nearly two tons of ore and one ton of coke are required to produce one ton of pig-iron. This ton of pig-iron, of average grade, and at normal times, is worth approximately $15. The price at present is three times this sum. In terms of normal operation, over a long period, three tons of ore and fuel, having a value of $8 or more, are required to produce one ton of pig-iron valued at $15. When such prices and production are contemplated for the West, the cost of transportation eclipses all other items. The increment in the ton-value of the material affected by the transportation and smelting, based upon the combined weight of fuel and ore, is less than $2 per ton. A slight increase in the cost of transportation easily consumes any allowance for the cost and profit in smelting. Water-transportation in the movement of iron-ore has been rated at 0.09c. per ton-mile, and land-transportation at 0.66c. on well developed lines. At this rate, the entire increment of operation would be consumed by a land-haul of the coke of 1000 to 1100 miles, or of the ore for 500 miles or more, or of the ore and coke for about 333 miles. In water-transportation, the distance would be seven or more times as great at a corresponding cost.

The freight-cost on pig-iron, at 60 to 75c. per hundred, from Pittsburg or New York, or 55c. from Chicago, brings war prices to the western coast in times of peace. Iron produced locally can be marketed, normally, at nearly $30 per ton. At any time, however, local smelting brought into competition only with existing prices, with the freight-costs added, brings no relief to local industries as a whole. The cost of production in the West must more nearly approach that in the East to warrant interest in the turning of industry from its established channels.

The extension to the West Coast of the standard industry of iron-smelting with coke is seen to require, not so much a gradual growth of many industrial interests as a single independent and energetic interest. By the standard methods of treatment, we could consider the iron industry to comprise five dependent steps. The ore is reduced to metal and manufactured into rails, rods, bars, plates, sheets, and structural shapes, or cast into forms for the consumer. The first, and primary operation, that of smelting the ore in the blast-furnace, is the only missing element to a complete chain of independent production in the West. This operation, carried on extensively in the Central, Eastern, and South-eastern parts of the United States, and in the West as far as Colorado, supplies pig-iron for the iron-foundry and the steel-plant, which may be regarded the second and the third branches of the industry. No large-scale substitute for the production of pig-iron in the blast-furnace has been demonstrated, as yet, to be practicable. The iron foundries are commensurate with the local need. By these the waste cast-iron, gathered from the surrounding country, is brought again to useful application. In the West, many foundries are relatively small, and are operating at a profit. Coke is the fuel commonly employed, but while a superior quality is to be preferred, grades inferior in some regards can be used. Oil fuel has been used in the foundry-cupola with the promise of economy and success. In experiments at one of the foundries in San Francisco, it was stated that about 8 gallons of crude oil per ton of iron would serve the cupola. The steel-plants on the Pacific Coast are relatively small, but for some years have been growing in importance. Plants of the open-hearth and bessemer types are represented. In the open-hearth plant, as operated in the East, pig-iron furnishes the greater part of the metal for the steel product, but with the pig-iron is used a suitable proportion of pure iron ore and also steel and iron scrap. So far as

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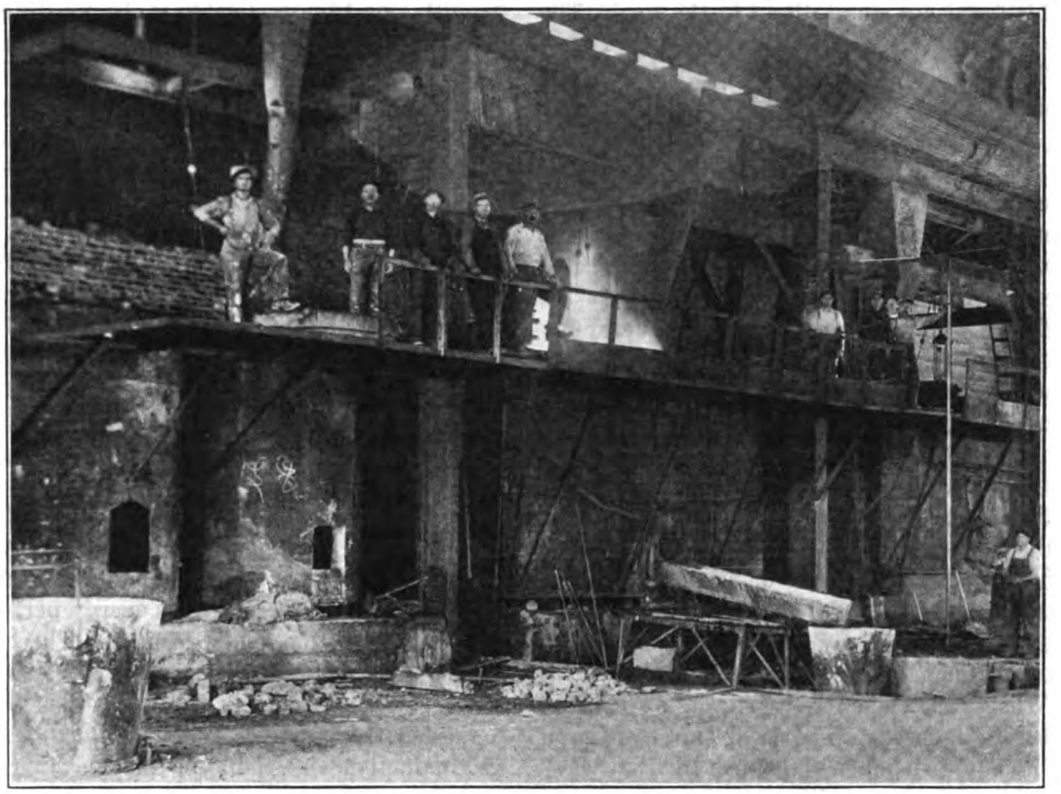
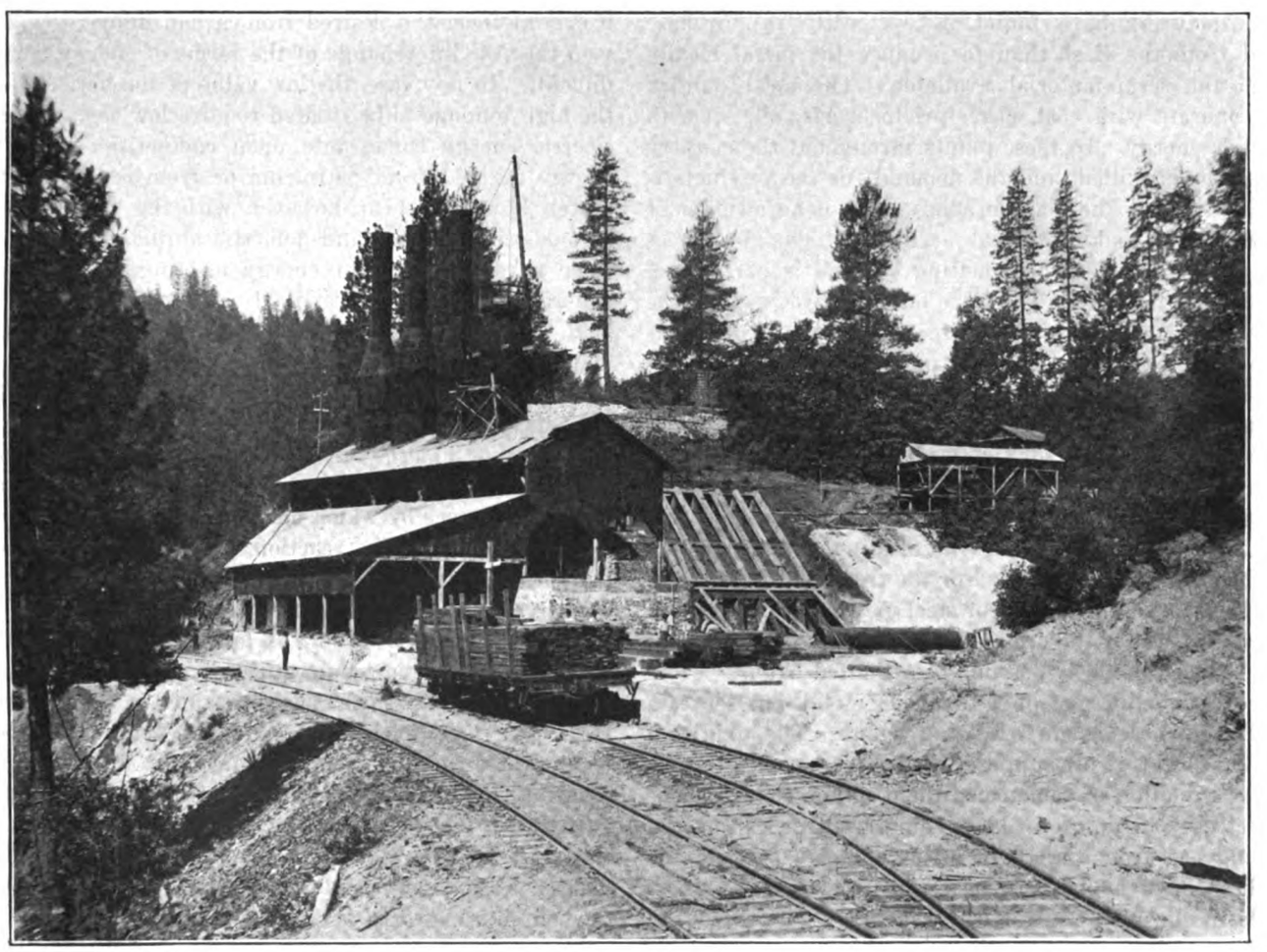


ELECTRIC FURNACES AT HEROULT, CALIFORNIA, PRODUCING FERRO-SILICON



NOBLE ELECTRIC STEEL PLANT, HEROULT, CALIFORNIA

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ore is used, this furnishes metal direct to the steel. The plant, to this extent, becomes a direct producer of steel from ore. The fuel commonly desired is producer-gas, but for the manufacture of gas a wide variety of fuels, including oil, can be used. The adaptation of the process to the West has led to the use of oil-fuel direct, with much success. Since, however, the tonnage of metal produced at the steel-mill practically equals that received in the raw condition, there is always the competition of steel made in proximity to the iron-furnace. The limitation falls more seriously upon the bessemer process than upon that of the open-hearth. The rolling-mills may be regarded as the fourth division of the industry. These supply the smaller shapes of structural steel to the building-trades and to the manufactories of machinery, including bolts, nails, rivets, and a great variety of iron and steel articles. These industries are acquiring importance in the West. The steel-foundries may be considered the fifth branch of the industry. There is an increasing demand for steel castings, which gives reason to believe that the time will come when light steel-castings will replace much of the heavy iron-structure in machinery. Waste steel has offered a supply of metal at a price not before equalled. The local supply of iron and steel is becoming depleted, however, by the heavy demand and high prices prevailing. The cost of producing steel from scrap in the West has been such that, in the past, in spite of the local supply of waste metal, manufacturers have found it less costly to purchase steel from the East than to produce the metal locally from the scrap-material available. The steel-foundry can operate with coal, coke, producer-gas, oil, or with electric energy. In these plants throughout the country the labor is skilled, and the demand for the products is largely local. The plant in many cases is an adjunct of a factory for making special machinery. The appliances are varied in which the melting of steel is performed. Much cast-steel is made by the crucible process. In the past few years the electric-arc re-melting furnace has come into application in many places.

There has been no success, so far, in making pig-iron on an extensive scale without coke. The use of fuel-oil, or of electric energy for the production of iron from ore, would be the first expedient in the development of a Western industry. Whether or not such methods can be developed to compete with existing practice is the problem to be considered. For the treatment of iron ore in the manufacture either of steel or iron, it is seen that the direct use of the ore along with a due proportion of the reduced metal is possible to a limited extent. Here the ore, or oxide, not only furnishes metal, but serves a useful purpose as an oxidizing agent. The oxidizing action, however, pre-supposes that there has been a previous reduction of some constituent of the charge. The direct use of iron ore in large foundry-furnaces for producing cast-iron directly from ore reverts back to the earliest days of blast-furnace smelting, and promises little in the way of practical economy. The direct reduction of iron, as in the American bloomary-process, is primitive and impracticable under existing labor conditions. The reduction of iron sponge, in a separate operation by the use of fuel other than coke, followed by the melting and casting of this reduced metal into steel-ingots of low carbon-content, involves a double operation which, compared with the standard processes is costly, since it divides the operation which, in the blast-furnace is conducted with the fullest economy in a single operation, into two separate steps, performed at different times, and with two separate applications of heat.

In the smelting of iron there is chemical and physical work to be done, only in part by the application of heat. There is slag to be melted, water-vapor, carbon di-oxide and other gases to be expelled, and various heat-absorbing side-reactions to be satisfied. A part of the heat is wholly lost in the liquefaction of products and in the formation and expansion of escaping gas. Notwithstanding the complex distribution of the energy, there is a part that is to be regarded as peculiarly and unalterably necessary to the process. This energy performs the service of reducing the oxide to metal. The heat consumed in fusing the metal may be partly recovered upon solidification, by improvements in construction that have been suggested from time to time. So also heat that is lost by conduction and radiation may be further decreased by improved heat-insulation or by improved furnace design.

In the case of the energy that is required to reduce the iron and form the desired iron-carbon alloy, it will be seen that the interchange of the forms of energy is more difficult. In any case, the low value of the material and the high tonnage to be treated require low cost. Hydro-electric energy comes into open competition with the energy derived from petroleum or from coal. Electric power, light, and heat, however, with the improvements in modern industrial and domestic applications, has become a refined form of energy meeting an increasing general demand. Oil, similarly, as a direct source of heat, is to be expected to find an indefinitely increasing market through the extension of known devices and methods of application and facilities for transportation. The maintenance of the high temperature required in the hearth of a blast-furnace requires consideration apart from that for other appliances. A reaction is sought in the blast-furnace by which metallic iron and a carbide of iron are formed. The reaction, which occurs only at a high temperature, absorbs heat at that temperature. Such reactions are likely to require appliances that are wasteful of energy. There is loss of heat in elevating the materials to the temperature of reaction and of obtaining a return from the heat contained in the products. Here the reduction of the oxide to metal requires a temperature ranging from 800° to 1800° F. In electric smelting, it is a simple matter to produce the heat, required for the reduction, by the arrangement of the electric arc, or by other suitable electric resistance. Reduction work, however, is not obtained by the heat alone. Carbon, in some form, is required in addition to the electric energy. The electrolytic capacity of the appliance

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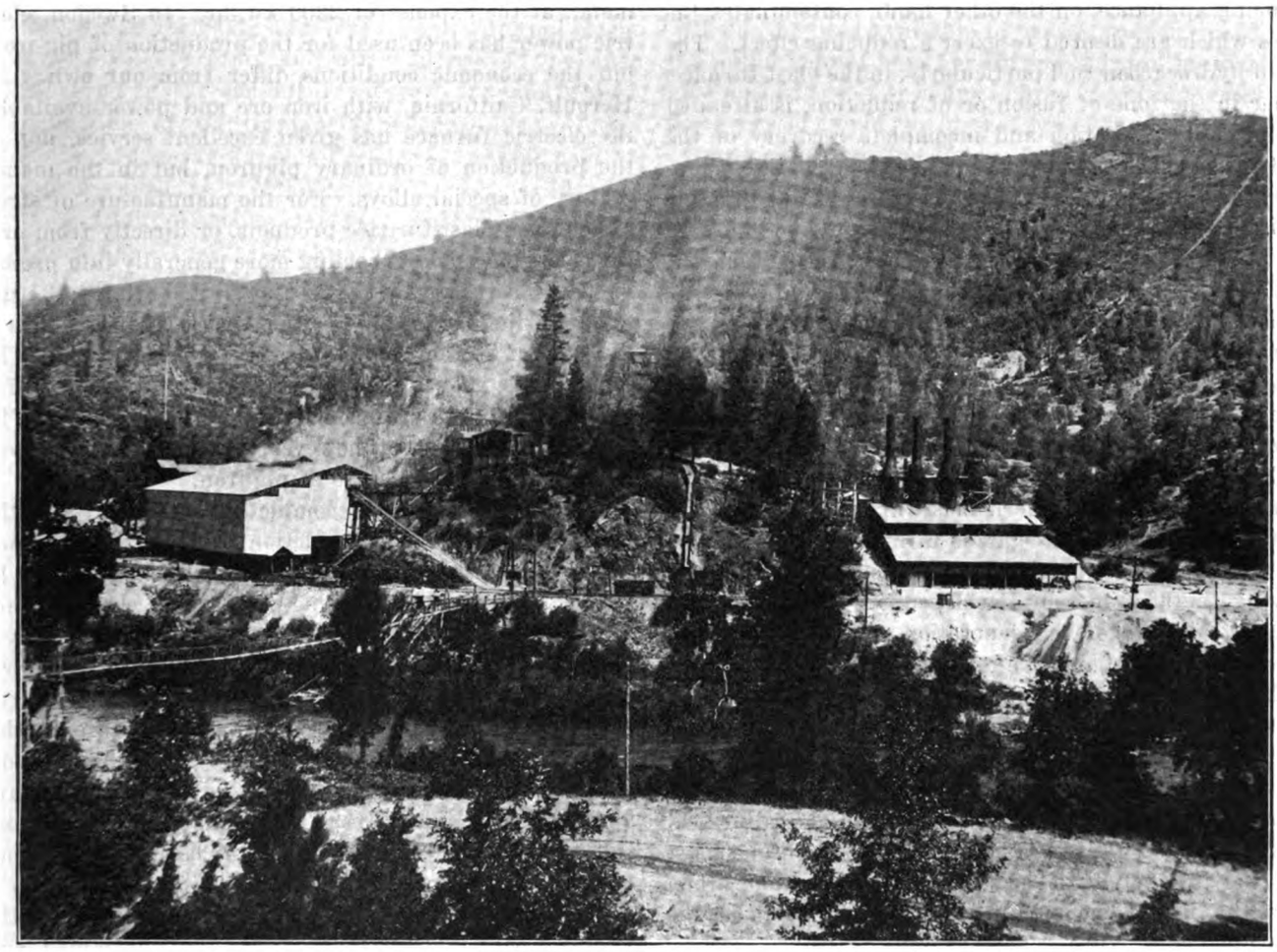
is too small and the electrolytic action too slight to justify the maintenance of the high temperature to secure it. In the effort to use oil in iron smelting, as a source of the heat, the products of combustion become troublesome. The gas from the combustion contains moisture from the hydrogen content of the oil. The water-vapor, along with the carbon di-oxide from final combustion, produce an oxidizing effect upon the iron and carbon, and interfere with the reduction.

The energy required in iron-smelting can be expressed in simple units. The reduction of one pound of iron from the sesquioxide (hematite) requires the consumption of fuel capable of yielding 3141 B.t.u. This heat, capable of yielding 3141 B.t.u., is absorbed in the process, and is not available as a heating effect. Aside from any consideration of heat required to satisfy this consumption, a given amount of carbon or carbon monoxide is necessary to carry on the action. However the reduction be performed, whether with carbon, carbon monoxide, hydrogen, or hydrocarbons, and whatever the heat-value of the fuel used to perform the reduction, this constant amount of heat-energy is absorbed from the reaction at the high temperature necessary. The heat-balance of the reaction of oxide with the fuel shows a slight excess of heat, which results in elevating the temperature after satisfying the heat-absorption. With solid carbon fuel, producing carbon monoxide as the end-product, there is an absorption of heat throughout, and the reaction is not self-sustaining but requires supplementary heat. The carbon necessary to effect this reduction would be approximately $\frac{1}{6}$ of the weight of the iron, in a case where carbon escaped from the reaction in the state of the higher oxide. Where the product of the reaction is carbon monoxide, the weight of carbon involved would be twice that amount. Similarly, if this carbon had been previously oxidized to carbon monoxide, and the reduction of the iron were performed by the carbon monoxide, the amount of carbon represented in the reaction would be approximately $\frac{1}{3}$ the weight of the iron. The reduction of such ore requires the application of carbon ranging from $\frac{1}{6}$ to $\frac{1}{3}$ lb. per pound of iron produced; and in the use of this carbon little or no heat is produced over and above that consumed by the reduction of the iron.



NOBLE ELECTRIC STEEL PLANT: IRON MINE ON RIGHT

The fuel consumed in blast-furnace practice approximates one pound of coke per pound of iron produced. The heat-value of coke, or of a medium grade coal, may be taken as 14400 B.t.u. per pound. This pound of coal or coke is equivalent to about 5.6 hp. hr. or 4.18 kw. It is the heat that would be expected from the complete combustion of about $7\frac{1}{2}$ cu. ft. of natural gas, $2\frac{1}{2}$ lb. of

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dry wood, $^2/_3$ lb. or $^1/_{12}$ gal. of petroleum. Its service in reduction is to furnish 3141 B.t.u. for the conversion of the oxide into 1 lb. of the metal. The balance, or $\frac{4}{5}$ of its heat-value, is available for the liberation of heat. For the economy of coke and the substitution of as much coke as possible by fuel other than coke, or by energy derived otherwise than by the combustion of coke, it is natural to look to some process that may permit of employing the $\frac{1}{6}$ to $\frac{1}{3}$ lb. of coke as the reducing agent, and of supplying the remainder from other fuel or other agents that can be locally provided. The application of heat by means of any exterior contact is attended with serious physical losses. The application of supplementary fuel within a reducing appliance, on the other hand, contaminates the gases which are desired to exert a reducing effect. The use of hydrocarbon fuel particularly, in the blast-furnace, either in the zone of fusion or of reduction, is attended by incomplete reaction and incomplete recovery of the heat-value. The employment of electric energy is opposed by a high unit-cost. The electric furnaces thus far devised, however, are small and ill-adapted to conserve the heat. In smelting iron by the use of any fuel, the full efficiency of the process can be secured only by utilizing the chemical energy contained in the waste-gas. Such waste-gas, of necessity strongly reducing, when issuing from the smelting appliance, is a fuel superior to any that easily can be supplied from an auxiliary source, produced from other fuel. The heat-units described above represent the effect of complete combustion of the gas. In modern blast-furnace smelting, the heat, latent in the waste-gas, is utilized by burning the gas where complete combustion can be secured, and employing the heat thereby developed for pre-heating the entering air, or for the generation of steam. The recovery of the waste-heat is an essential economic factor.

Efficiency under the conditions of high-temperature reactions generally implies a need of recovering the heat latent in the products issuing from the appliance after the reaction has occurred, and the avoidance of loss by radiation and conduction. In certain metallurgical operations the desired reactions occur spontaneously, and the production of heat sustains the action, when once the initial means are provided to produce the requisite temperature.

When the magnitude of the blast-furnace is considered, with its height of 75 ft. or more, and its diameter of 15 ft, and its large content, relative to its exterior exposure, and when the long experience with the blast-furnace is considered, with the improvements that time and ingenuity have wrought in its details, there will be less expectation of substituting small appliances for it with an idea of securing comparable efficiency. No one objects to the blast-furnace as an economic appliance. The objection is to the restriction in securing practical fuel. The effort to use a volatile fuel in the blast-furnace, or in any direct modification of a blast-furnace involves ineffectual reduction, and poor economy in heat units. In the shaft-furnace there is difficulty in keeping the charge open for the passage of the necessary gas. The use of solid fuel of high fixed-carbon provides the means for this. The use of electric energy for the production of the pig-iron fails to provide the required reducing action. In addition to heat derived from this source, some $\frac{1}{10}$ lb. of fixed-carbon is required for each pound of pig-iron reduced. The gaseous product is irregularly supplied, and its utilization has not thus far been made practicable. The consumption of electric energy is found practically to amount to 2200 kw.-hr. per ton of iron produced, in addition to the coke, charcoal, or other fixed-carbon fuel consumed. Here the substitution of electric energy for coke results in the saving of approximately 0.6 tons of coke per ton of metal, at the expense of 2200 kw.-hr. In Sweden, electric power has been used for the production of pig-iron, but the economic conditions differ from our own. At Heroult, California, with iron ore and power available, the electric furnace has given excellent service, not in the production of ordinary pig-iron, but in the manufacture of special alloys. For the manufacture of steel, either from blast-furnace products, or directly from ore, the electric furnace is coming more generally into prominence. There are in use in the United States 43 furnaces of the Heroult type, the largest of which has a capacity of 20 tons, and 14 of the Snyder pattern. The industry is growing, and the present conditions offer extraordinary encouragement for its development. The manufacture of steel, however, is an industry subordinate to the manufacture of pig-iron.

The development of a complete iron industry in the West, to include the production of pig-iron, demands special encouragement. Ideal conditions are not to be found. The abundant coking coal, found elsewhere adjacent to iron ore and limestone, is denied the West; yet its absence has engendered the greater need. The requirement of the West is not to be measured by standards elsewhere. The need is to discover possibilities under conditions that have been thought of with disfavor. Herein the proposed and untried processes that have appeared from time to time merit final and critical consideration. The blast-furnace must be thought of, not for what it can do at its best, but for what it could do if operated with the fuel that is to be had. The ores of the Pacific Coast must be more thoroughly examined and made better known. Transportation, for the movement of coke, must be encouraged by industry as a whole, and the local and national benefit from it fully recognized. The use of ore must be fostered in steel manufacture and in every local process where it can be employed; and until a way is found to produce sufficient pig-iron for local industry, local ores should be developed to supply this need. Beneath the high prices of the present time there can be read, in terms of past prices, the possibility of continuous and profitable future operation. In every phase of the industry the way is now cleared for expansion by the supreme commercial inducement for industrial activity. An iron industry in the West required, perhaps, nothing less than a world-war for its conception, but in coming it will find a permanent abode.

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Measures Recommended for Relieving the Californian Oil Shortage

In May 1917, Governor Stephens appointed a subcommittee of the California State Council of Defense to investigate the petroleum situation in California. This committee was composed of Max Thelen, president of the State Railroad Commission, chairman, David M. Folsom, professor of mining at Stanford University, and Eliot Blackwelder, professor of geology at the University of Illinois. The committee made a tour of the oilfields of the State and held several informal meetings with oil operators and other interested persons. An abstract of the committee's report appears below:

Utilization of Californian Petroleum: Californian fuel-oil operates the Panama Canal; the greater part of the steam-railroads of Washington, Oregon, California, Nevada, Utah, Arizona, and New Mexico; the steamship lines along the Pacific Coast from Mexico to Alaska and across the ocean to Hawaii; the artificial-gas plants of California, Oregon, Washington, Nevada, Arizona, and Hawaii; the mines and smelters of California, Nevada, and Arizona; the cement-plants and sugar-refineries of California; and a large part of the manufacturing, industrial, and agricultural enterprises of the Pacific Coast States. It supplies the Pacific Coast fuel-requirements of the United States Navy and Army and of the various State and municipal governments. To a considerable extent, it operates the railroads and industries of western Canada; the sugar-refineries and railroads of Hawaii; and the railroads, steamship companies, mines, and smelters of the west coast of Central and South America.

The products of Californian petroleum, such as kerosene, gasoline, distillates, lubricants, and road-oils fill the needs of Arizona, California, Nevada, Oregon, Washington, Alaska, and Hawaii. Californian kerosene is shipped to China, Japan, India, and Australia, and to the western coast of Central and South America. Californian distillates and lubricants are sold in England, Canada, and Australia.

Important as is the part which Californian petroleum and its products have heretofore played in the industrial life of the nation during times of peace, much more important is the part which it should and will play, if possible, in meeting the emergency in the supply of fuel-oil, gasoline, and lubricants, created by the War.

Production: California produces between one-fourth and one-fifth of the world's supply of petroleum. The year of California's greatest production was 1914, when 103,620,000 bbl. was produced. Production fell in 1915 to 89,570,000 bbl., and increased slightly in 1916 to 91,820,000 barrels.

Notwithstanding the fact that a net average of 52 new wells was added to the producing wells of California during each month from January to May, 1917, inclusive, and the fact that drilling during these months was more active than during any other period for the last three or four years, the daily production was slightly less in May than in January. Unless the measures hereinafter recommended for increasing production are adopted, it is improbable that production in 1917 will exceed the 1916 production by more than 2,000,000 bbl., if at all.

From the data available to us, we are convinced that the public cannot hope for further substantial increases in California's petroleum supply resulting from the discovery of important new fields or from considerable extensions of existing fields.

Consumption: The consumption of Californian petroltum in 1916 was 104,930,000 bbl., being more than 13,100,000 bbl. greater than the production. The excess was taken from storage. During the first five months of 1917, consumption outran production 5,415,000 bbl., or 1,083,000 bbl. per month, and 35,860 bbl. per day.

Because of the normal increase in consumption as well as the additional extraordinary requirements of the War, which are already being felt, it is doubtful whether consumption in 1917 can be reduced below the consumption of 1916, notwithstanding the substitution of other fuel or power, and the further possibilities of conservation mentioned in this report.

Consumers of Californian petroleum will shortly face a condition of decreasing production and increasing demand. This condition points inevitably to the necessity of developing other sources of fuel or power.

Storage: Crude-oil stocks in California were reduced from 57,147,000 bbl. on December 31, 1915, to 44,036,000 bbl. on December 31, 1916, a reduction during the year of 13,110,000 bbl., or 23%. The total remaining storage on June 1, 1917, is reported to have been slightly in excess of 38,000,000 barrels.

Part of the oil in storage cannot be utilized because it is situated below the outlets of tanks and reservoirs or is being used for the operation of oil pipe-lines or for similar reasons. Of the total stocks on June 1, 1917, not more than 32,000,000 bbl. was available for use. Of this amount, 12,000,000 bbl. was refining-oil. This would yield approximately 7,000,000 bbl. of residuum. On June 1, 1917, there was available from crude-oil stocks approximately 27,000,000 bbl. for fuel. If the present excess of consumption over production, amounting to an average of 1,083,000 bbl. per month, continues, the entire available storage of Californian fuel-oil will be exhausted by June 1, 1919. If a margin of safety of 10,000,000 bbl. of fuel-oil is maintained, and if the present relationship between production and consumption continues, that margin will be reached by September 20, 1918.

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If consumption is materially increased, as seems likely, both because of normally increased requirements, as well as the extraordinary requirements of the War, or if production decreases, as seems likely unless the relief herein recommended is given, both the margin of safety and the complete depletion of all Californian stocks will be reached considerably before the dates indicated.

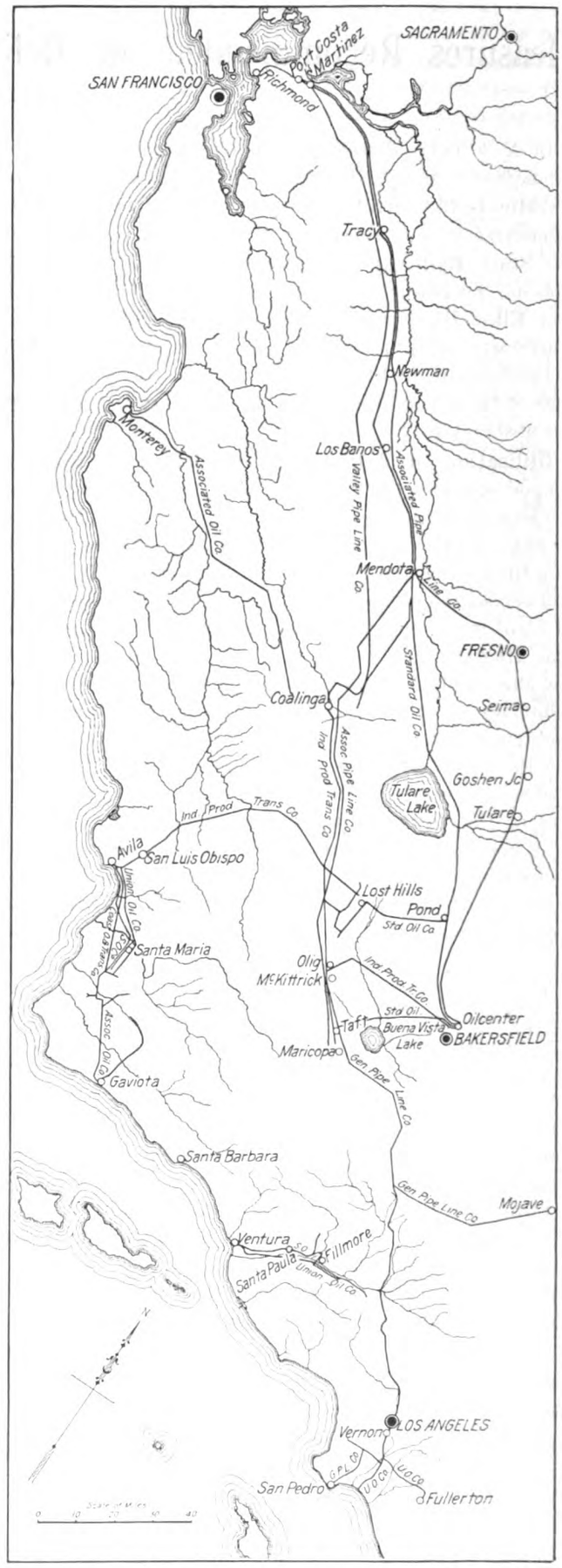
The principal railroads of California, with the exception of the Southern Pacific Co., have made the necessary arrangements to meet their requirements for at least one year. At the present rate of production by the Southern Pacific Co.'s fuel-oil department, bearing in mind also the purchases of fuel-oil by the Southern Pacific Co. including 1,000,000 bbl. bought from the Union Oil Co. and not used as yet, the Southern Pacific Co.'s stocks of fuel-oil will be exhausted by December, 1917, unless the recently initiated additional drilling operations increase its production and unless it effects a substantial saving of fuel-oil by converting to coal those parts of its system which are near the coal-mines in Washington, the Rocky Mountain States, and New Mexico. If the receipts of fuel-oil by the Southern Pacific Co. decrease or its consumption increases, the depletion of its stocks will occur before December 1, 1917.

If the company's stocks should be exhausted, it would be necessary for it to enter the market to purchase oil from the general stocks. These stocks are owned principally by the Standard Oil Co. and the Union Oil Co. If these companies should be unwilling to sell fuel-oil to the railroads, we assume that the Federal Government would have the right to commandeer the stocks and to compel their delivery for the operation of the railroads as long as the stocks last. Such action, if on a large scale, would necessarily deprive other important industries of petroleum and its products.

Conservation: Field-losses of petroleum in the Californian fields have been almost entirely eliminated and the amount of fuel-oil used in field-drilling and pumping has been reduced considerably by the substitution of natural gas and of electric energy. The operators are now taking steps to reduce further the present field consumption of approximately 8500 bbl. per day, by the installation of jacks and electric motors. The use of fuel-oil in the fields for pumping and drilling cannot be entirely eliminated.

The principal petroleum refineries of California are working on improved processes of refining. The amount of crude oil which is being refined is increasing and a proportionally larger amount of gasoline and lubricants is also being secured. The result has been a large surplus of kerosene, which it has been necessary to export to the Orient, Australia, and Central and South America.

Mexican petroleum was substituted early in 1917 for Californian petroleum amounting to approximately 2,750,000 bbl. per year, heretofore sold by the Union



OILFIELDS AND PRINCIPAL PIPE-LINES OF CALIFORNIA

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Oil Co. in Chile. A considerable part of the remaining 3,000,000 bbl. of Californian fuel-oil sold in 1916 on the west coast of Central and South America, including the Panama Canal, can likewise be saved by the substitution of Mexican petroleum from Tampico and Tuxpam. By reason principally of transportation difficulties, Mexican petroleum will not be available, during the War, as a further substitute for more than 3% of Californian petroleum. After the end of the War and the resumption of normal transportation-conditions, we may assume that Mexican petroleum will be an important factor in the commerce and industry of a considerable part of the Pacific Coast of North, Central, and South America.

Coal cannot be substituted for Californian fuel-oil to any considerable extent during the War because of present difficulties in the production and transportation of coal. Approximately 1,000,000 bbl. of Californian fuel-oil will be saved in the ensuing year in the North-West by the substitution of coal for Californian fuel-oil by the Oregon Short Line and other industries. The Los Angeles & Salt Lake Railroad Co. and the Western Pacific Railroad Co. are converting parts of their systems in Utah and Nevada from Californian fuel-oil to coal produced in the Rocky Mountain States. The Southern Pacific Co. and the Atchison, Topeka & Santa Fe Railway Co. can also convert gradually from fuel-oil to coal those parts of their systems which are near the coal-mines of the North-West, the Rocky Mountain States, and New Mexico. Apart from what has already been accomplished and the further possibilities herein indicated, there is little possibility of further conversion from Californian fuel-oil to coal during the War, unless the conditions surrounding the production and transportation of coal change materially.

Powdered coal has been used successfully in cement-plants, stationary boilers, power-plants, and metallurgical furnaces. One cement-plant in the North-West has recently converted its plant from Californian fuel-oil to powdered coal, resulting in an annual saving of 84,000 bbl. of Californian fuel-oil. Apart from a possible slight additional saving in the North-West, it is not reasonable to expect that powdered coal will be further substituted for Californian fuel-oil during the War.

Hydro-electric energy has already been substituted to a considerable extent for Californian fuel-oil in industrial and agricultural uses, but the difficulty in securing copper and other material and the disturbance of existing conditions are such that large additonal savings of Californian fuel-oil by the substitution of hydro-electric energy cannot be expected during the War. A small saving of Californian fuel-oil can be effected, during the War, by the further substitution of electric motors for fuel-oil in the Californian oilfields and by such interconnection between the systems of various electric companies as will eliminate or reduce the necessity of maintaining steam-electric plants. After the termination of the War, and the restoration of normal industrial conditions, we may expect that hydro-electric energy will play an increasingly important part as a substitute for fuel-oil in all the Pacific Coast States in which such energy is available.

Natural gas has already been substituted to almost the entire extent of its supply, for fuel-oil in the Californian fields, and for fuel-oil and artificial gas for higher industrial and domestic uses. The maximum production of natural gas in the Californian fields has been reached and it is not to be expected that natural gas will, to any considerable extent, further replace other forms of fuel.

We conclude that during the War some further saving of Californian fuel-oil is possible by elimination of losses and substitution of other forms of fuel or power, but that no large saving can be effected without serious impairment to the efficiency of the transportation systems and industries of the Pacific Coast.

The great importance of gasoline and lubricants must be recognized and steps should be taken as soon as is reasonably possible to the end that no more unrefined petroleum shall be burned by railroad companies or other industries. No part of Californian petroleum should be thus burned except the residuum left after refining.

If a sufficient amount of fuel-oil cannot be secured from Mexico after the War, the railroads and other industries of the Pacific Coast must gradually make arrangements to use other forms of energy such as hydro-electric energy or powdered coal.

Remedial Measures: The remedy which imperatively presents itself in view of the emergency created by the War, is the prompt and substantial increase in the production of Californian petroleum.

While we do not desire to minimize the results which can and should be accomplished by the further diminution of field losses, the higher use of petroleum and its products and the substitution of other forms of fuel or power, during the War as well as thereafter, the cardinal fact remains that the only means which will be effective in a large way to meet the present emergency is a prompt, substantial increase in production. We estimate that this increased production should amount to more than 30,000 bbl. per day and that such increased production cannot reasonably be expected before June 1, 1918. Each difficulty standing in the way of prompt and substantial increased production must be quickly solved if this increased production is to be obtained in time to forestall a serious industrial crisis.

Increased Production—Material: The necessary increased production cannot be secured unless large additional amounts of oil-well casing, drill-pipe, and other oil-well material are promptly brought into California. The oil-well supply-houses report that they can fill no orders for complete drilling-outfits in addition to those already taken.

The larger oil companies have on hand or have placed orders for enough material to complete their 1917 drilling operations as heretofore planned, but no material for additional drilling beyond such plans. Many small

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operators report that they would drill if they could secure the necessary material but that it has been impossible for them to secure such material, even at the high prices now prevailing. Federal receiver Howard M. Payne states that he is willing to drill, if authorized by the Federal Court, but that he does not know where he can secure the necessary material.

Increased Production—Labor: Over 80% of the laborers who are employed in the oilfields and refineries are skilled men, most of whom it would be difficult to replace. If any considerable number of these men are taken from their present employment, it will be impossible to increase the production of petroleum in California and difficult even to maintain the present production. About 4% of these men have already left their employment and have volunteered for service in the various branches of the U. S. Army and Navy. About 40% of these employees have registered for the draft. We suggest the advisability of bringing this situation to the attention of the Federal Government.

Increased Production—Land: In order to secure an increase of 30,000 bbl. per day in the production of Californian petroleum, drilling must be done on lands which will yield the largest production in the shortest time by the expenditure of the smallest amount of drilling material and labor.

In order of productivity with due regard to time and economy of drilling material, such lands are situated principally in (1) the Buena Vista hills (Midway field), (2) the Coyote hills and La Merced (Whittier-Fullerton field), (3) the Sunset field, and (4) the East Coalinga field.

Of the most desirable undrilled lands, approximately 70% are involved in litigation with the Federal Government. Nearly one-half of the best undrilled proved petroleum lands are claimed by the Southern Pacific Co., under patents heretofore issued to it, but now in litigation. Of the remaining lands in litigation, a part of the most productive undrilled land is in the care of Howard M. Payne, Federal receiver.

The most promising land in the Coyote hills and La Merced is owned partly by the Standard Oil Co. and partly by the Union Oil Co. This land is not involved in litigation. The wells in this district, however, are much deeper than in the Midway field and the limits of the productive territory have not as yet been defined.

The desirable Buena Vista Hills lands are practically all in Naval Reserve No. 2. A considerable area, however, of presumably productive undrilled proved land, which in our judgment should be promptly and intensively drilled, is in the Sunset field and in the East Coalinga field. Most of this land is claimed by the Southern Pacific Co. Part of it, particularly in the Sunset field, is in the posession of the Federal receiver. These latter lands, in our judgment, should be drilled promptly, not merely because of the large production that can presumably be secured therefrom, but also because water is known to be encroaching on them and probably will ruin them in large measure unless they are drilled promptly.

The oil companies which own undisputed patented lands of presumed productivity are under a grave responsibility to increase production in the present emergency. With the possible exception of one of the larger concerns, we are of the opinion that these companies are striving earnestly to meet this responsibility. Some operators are drilling wells which require the expenditure of a large amount of material and labor for a relatively small production.

Increased Production—Transportation: When the conversion of the Standard Oil Co.'s six-inch pipe-line from the Whittier-Fullerton field to the refinery at El Segundo to a ten-inch line has been completed, the oil pipe-lines of California, if properly administered and correlated, will be sufficient to take care of the pipe-line transportation of such increased production as may reasonably be anticipated.

The legislature of California has declared that oil pipe-lines are common carriers and are subject to the jurisdiction of the State Railroad Commission. The question whether the oil pipe-line statutes are constitutional has been submitted to the Supreme Court of the State of California. If the legislation is sustained the Commission will have authority to supervise the oil pipe-lines so that they may be operated to the greatest efficiency from the point of view of the entire transportation-situation. If the jurisdiction of the Commission is not sustained, some other means must be provided so that the oil pipe-lines may be operated to full efficiency in the present emergency.

A more efficient correlation of the use of oil pipe-lines, railroad tank-cars, and tank-steamers would result in the release of a considerable number of tank-cars that are needed to serve the industrial needs of California and neighboring States. The Standard Oil Co. reports that it is 3500 tank-cars short at its refinery at El Segundo and that it is accordingly unable to fill urgent orders from the copper-mines of Arizona.

Increased transportation facilities may hereafter become necessary if the fields of southern California should be called upon, from their surplus production, to help meet the requirements of central and northern California and other territory.

We submit the following recommendations:

1. Increased Production: We recommend that every reasonable effort be made to increase the production of Californian petroleum promptly and that to this end additional drilling be undertaken, as quickly as material and labor are available, on the lands on which the largest additional production can be developed in the least time and with the smallest expenditure of material and labor.

2. Decreased Consumption: We recommend that every reasonable effort be made, consistent with the maintenance of the efficiency of our transportation systems and industries, to conserve the supply of Californian petroleum by the diminution of field losses, the

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higher use of petroleum and its products, and the substitution of other forms of fuel or power.

3. Presentation of Facts to Federal Government: We recommend that the facts with reference to the Californian petroleum situation, including specifically the imperative necessity for additional production and the relative productivity of undrilled but proved lands, be presented to the President of the United States and to the appropriate departments of the Federal Government, and that the Federal Government be urged to render every possible assistance consistent with the highest public interest.

4. Oil-Well Material: We recommend that the attention of the Federal Government be drawn to the advisability of directing the manufacturers of oil-well supplies to set aside sufficient capacity of their plants for the production of oil-well casing, drill-stem, cable, and other material to supply the reasonable requirements of California and other parts of the United States, and of directing the railroads to transport such supplies as expeditiously as is consistent with other urgent requirements.

5. Labor: We recommend that the attention of the Federal Government be drawn to the advisability of exempting from service in the armed forces of the Nation all skilled workmen employed in the petroleum industry and of indicating to such workmen that their highest present duty is to assist in the maintenance and development of the petroleum industry.

6. Lands in Litigation Where There is no Receiver: We recommend that the Federal Government be requested, in those instances in which Californian petroleum lands now in litigation with the Federal Government are not in the hands of the Federal receiver, to consent, through the Department of Justice, to stipulations under which the claimants will be permitted to drill such lands intensively under an arrangement by which the Federal Government, if it ultimately wins the suits, will be protected with reference to the petroleum thus produced, and the operators will be protected, if they lose the suit, out of the proceeds of the petroleum thus produced, to the extent of at least their expenditures reasonably and fairly made under such stipulations.

Whether any additional drilling shall be done on lands in Naval Reserve No. 2, is a matter which must be left to the wisdom and fairness of the Federal Government, when the Government has before it all the facts, including the needs of the Government, present and future, the extent and the effect of the past and present production in this reserve, the urgent necessity for increased production of Californian petroleum, the relative productivity and availability of undrilled proved lands, and the fact that on any reasonable assumption an additional production of at least 30,000 barrels per day cannot be secured unless some additional drilling is done in Naval Reserve No. 2. We recommend, however, that pending a determination as to additional drilling in Naval Reserve No. 2, all other Californian petroleum lands in litigation be at once thrown open to production under the arrangements herein suggested.

7. Lands in Litigation in Possession of Receiver: We recommend that the Federal Government be requested, in those instances in which Californian petroleum lands now in litigation with the Federal Government or in possession of the Federal receiver, to take appropriate proceedings, through the Department of Justice, so that the receiver may be authorized or directed to proceed at once to drill intensively such lands as are presumptively productive and particularly the lands which are likely to suffer from the infiltration of water, unless drilled.

If the authority of Congress is necessary, we recommend that Congress be requested to enact the required legislation.

8. Legislation to Open Petroleum Lands: We recommend that the Federal Government be requested to enact legislation by which such lands in the public domain as the Federal Government may consider wise and consistent with public interest will be opened to petroleum development on terms just and reasonable both to the Federal Government and to such explorers and operators as have heretofore proceeded or may hereafter proceed in good faith to the exploration and development of petroleum lands. We suggest that the area of the lands in each instance be sufficiently large to permit efficient operation.

We believe that the establishment of a definite constructive policy in this matter will have a wholesome and stimulating effect on the petroleum industry of California and other States.

9. Transportation: We recommend that the railroad, steamship, pipe-line, and oil companies of California be authorized and directed to take steps so to correlate their facilities as to make most available and efficient every agency employed in the transportation of Californian petroleum and its products.

10. Ultimate Conservation: We recommend that, as soon as is reasonably possible, bearing in mind the paramount necessity of the most efficient operation of our transportation systems and other industries during the emergency created by the War, the further burning of Californian petroleum unless it has first been refined, be prevented, the higher use of Californian petroleum and its products insured, substitute forms of fuel or power developed, and the supply of Californian petroleum for the most efficient use thereof conserved.

Unfilled car-orders for the railroads of the United States on May 1 amounted to 143,627. On June 1 this number had been reduced to 106,649, and on July 1 to 77,144, or a total reduction in two months of over 66,000. This was in spite of the increasing transportation-needs of the country during this time. Preference on most roads is now being given to coal over all other freight. During June, 750,323 cars of bituminous coal was hauled, against 595,000 during the same period last year, an increase of 26.2%.

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The Petroleum and Gasoline Situation*

By VAN H. MANNING†

In 1916 there were 2,750,000 automobiles in the United States, an increase over 1910 of 2,350,000. Automobiles used in 1916 28,000,000 bbl. more gasoline than in 1910. This increased use of gasoline for the increased number of automobiles alone represented a little more than half of the total output of gasoline in 1916, the total production being about 54,000,000 barrels.

The total gasoline-engine horse-power built and sold in the United States in 1913 was 11,200,000. In 1915 the output had a little more than doubled, the amount being 22,500,000 hp. These figures indicate the increased use of gasoline-power more clearly than those which cover automobiles only, since they include all types of gasoline-driven machinery.

Of the gasoline produced in the United States, between 55 and 60% is used in automobiles; 20 to 25% is exported; and the remainder is used in stationary engines, motor-boats, tractors, and for various purposes of minor importance.

As the highways of the country are improved, the commercial trucks, consuming large quantities of motor-fuel, are becoming important means of transportation in many localities. The fishing-fleets of all our coasts have installed gasoline-power to replace their original sailing-equipment. These fleets, with the many pleasure-craft, operated mostly in the summer months, when the production of gasoline is most heavily taxed, use large quantities of this convenient liquid fuel. There seems no reason to believe that the demand for gasoline will be reduced, in fact, a much larger demand seems imminent.

As the production of gasoline depends upon the supply of petroleum, let us look to the source and see what we find. Petroleum and its products have become essential to our existence. Gasoline is an important product, but there are many others. The operation of all machinery is made possible by the use of lubricating-oils, and these come from petroleum.

In discussing the supply of and demand for petroleum in this country during the past few years, permit me to say that the stored reserve of petroleum is the most stabilizing influence in the industry. I wish also to bring out the fact that recently our increased consumption has made it necessary to draw oil from this storage. This has convinced many people that our present supply has reached a point where it may never again be sufficient to fill easily the demand placed upon it, unless some radical steps are taken to conserve its use. In particular, the burning of crude petroleum under boilers for the generation of steam ought to be stopped. In this way large quantities of priceless by-products are being consumed.

In 1916, the marketed production of crude petroleum was, according to the estimate of the United States Geological Survey, 295,000,000 bbl. The stocks held by various pipe-line and transportation companies at the end of January, 1916, were 170,000,000 bbl. and at the end of 1916, 150,000,000 bbl., a decline of 20,000,000 bbl. in spite of the fact that our production exceeded all previous records.

If consumption of crude petroleum exceeds production, the difference must be drawn from storage. During 1915,

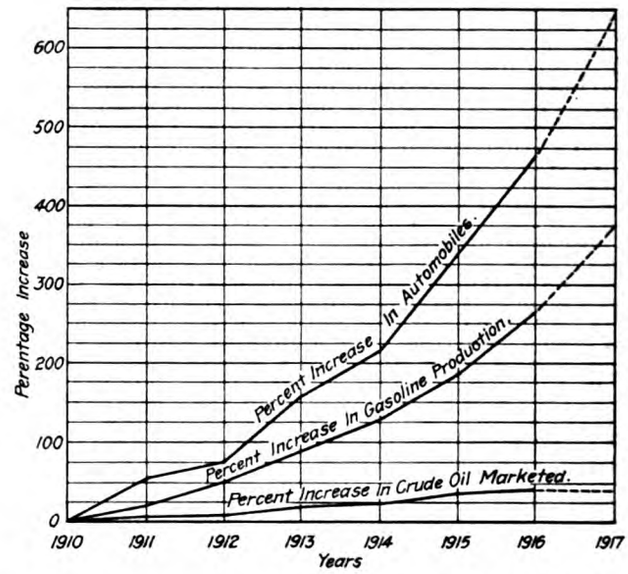

DIAGRAM SHOWING INCREASE IN AUTOMOBILES AND IN GASOLINE AND CRUDE-OIL SUPPLY

the consumption of crude petroleum was 12% greater than in 1914. In 1916, the consumption exceeded the 1915 consumption by 13%. Estimating that the normal peace consumption for this year will increase at the same rate, or 13%, our consumption for 1917 will exceed that for 1916 by about 40,000,000 bbl. This does not take into consideration the increased demand for petroleum and its products because of the entrance of this country into war. Although this increased demand because of the War is difficult to estimate, it will, undoubtedly, be considerable. The production of crude petroleum in this country during last year is thought to have reached high-water mark, and it is likely that the production for 1917 will be smaller than it was last year. If the normal and war demands for petroleum can be filled, the difference between the estimated production and consumption during this year will probably be as much as 60,000,000 bbl., an amount which must be drawn from storage. With only

*Part of address delivered at the Editorial Conference of the Business Publishers' Association, Washington, D. C., May 25, 1917.

†Director, U. S. Bureau of Mines, Washington, D. C.

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150,000,000 bbl. in storage at the beginning of the year, it is evident that some radical steps must be taken to meet the situation.

While the present increase in the number of pleasure-cars may not continue, it is plain that the use of gasoline for the production of power in many commercial fields has not yet fully developed. As this use increases it will more than overcome any possible reduction in the consumption of gasoline in cars used for personal purposes.

The fact we must face is that the production of petroleum is not increasing as rapidly as the production and consumption of gasoline. Petroleum in time will reach its maximum production and start to decline. What we are doing now is looking to more efficient methods of production from the oil-sands, the production of more gasoline by the so-called cracking-process, the extraction of vapors from natural gas, and the utilization of liquid fuels from other than petroleum bases.

More efficient methods of production are now being developed, such as the Smith-Dunn process for forcing oil from the sand by the use of air or gas under pressure. The cracking of petroleum last year furnished 7½% of the total gasoline production and is being developed and installed rapidly in most of the larger fields of the United States. The treatment of natural gas by compression, refrigeration, and absorption, produced 60,000,000 gal. of gasoline of such a low boiling-point that it was mixed with equal parts of naphtha to form 120,000,000 gal. of good motor-fuel. The compression and refrigeration process of extracting gasoline from natural gas, when first used, treated only gases containing 3 gal. or more of condensable vapors per 1000 cu. ft., but at the present time the development of the process and the increased price of the product make gas carrying 1 gal. profitable. The extraction of gasoline from gases containing considerably less than 1 gal per 1000 cu. ft. is now being done profitably by the absorption process, which is well adapted to treating lean gases in large volumes. Another source of petroleum, which will undoubtedly be developed in time, is found in the shales containing considerable quantities of oil but which, at present prices, cannot be extracted commercially. Substitutes for gasoline, such as the products of the distillation of coal, are now being used in Europe for motor fuels, and may in time be used in this country, as many by-product coke-ovens are being constructed.

DRILLING DEEP WELLS*

In 1898 the Forest Oil Co. drilled what at that time was the deepest well in the United States. This well was at West Elizabeth, Allegheny county, Pennsylvania, 12 miles south-east of Pittsburg on the William Bedell farm. It was the intention to drill to the Corniferous limestone, but because of an accident the tools and 1000 ft. of cable were left in the hole at 5575 ft. The temperatures found in this well were as follows: At 525 ft., 57°F.; at 2252 ft., 64°; at 2397 ft., 78°; at 5010 ft., 120°; at 5380 ft., 127° Fahrenheit.

The Hope Natural Gas Co. is drilling 25 deep wells in West Virginia. It has completed 8 wells at an average depth of 4600 ft. below the Pittsburgh coal. It also drilled one well to 6390 ft., but unfortunately plugged the hole at that depth.

There is a well being drilled at Volcano, West Virginia, in which this company has 4000 ft. of 10-in. hole.

There is also a well drilling on the Goff farm, near Clarksburg, West Virginia, in which there is already 6500 ft. of 8-in. hole. The deepest well in the world was drilled to a depth of 7349 ft. near Luchow, Germany.

The next deepest well and the deepest in the United States is being drilled by the Peoples Natural Gas Co. on the R. A. Geary farm in Washington county, Pennsylvania, near McDonald. At the present time this well is 7247 ft. in depth and is delayed by a fishing-job.

The well was commenced November 7, 1911. The rig is of oak, 26-ft. base and 90 ft. high, double-legged and the legs reinforced by having 6 by 6-in. oak timbers running from base to crown-block inside of the legs. The band-wheel is 13 ft. diameter, with a 7½-in. shaft, bull-wheels 24 ft. diameter with 6-in. steel gudgeons using three tug-ropes and two 12-in. brake bands. The sand reel is 15 ft. long with a 5-in. shaft and 43-in. friction-pulley.

The engine is a 14 by 14-in. Ajax 52-hp., steam being furnished by two 25-hp. boilers. The belt was specially made and is 105 ft. by 16 in. The tools used were all standard. The crown pulley is a special wire-line pulley 38 in. diam. with 6-in. steel gudgeons and weighs 700 pounds.

Up to the present time ten cables and three sand-lines have been used. The first cable used was a 1-in. wire-line 7000 ft. long. The next seven cables were 8000 ft. long, and on account of the weight were built specially, being tapered, 1¼-in., 1⅛-in., 1-in., and ⅞-in. The sand-lines used were $\frac{9}{16}$ in. diameter and 8000 ft. long.

In drilling, a 16-in. hole was started and at 232 ft. a string of 13-in. casing was set. The 13-in. hole was drilled to 1050 ft. and a string of 10-in. casing set; 10-in. hole to 1969 ft. and a string of 8¼-in. casing set; 8¾-in. hole to 6053 ft. and a string of special 6-in. casing, weighing 68 tons, set; 5¾-in. hole drilled to 7247 ft. and a string of special 4¼-in. inside diameter by 5¾-in. outside diameter casing, weighing 62 tons, set. This string of casing had welded joints instead of collars, making it one continuous piece.

The company intends to carry this well to a depth of 8000 ft. or more. The U. S. Bureau of Standards is making measurements of the temperature in the well from time to time.

*Abstract from paper presented at the twelfth annual convention of the Natural Gas Association of America, by A. R. Gray.

Electric motors now in use on oil-wells in California number 850 and the total capacity is 23,100 horse-power.

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COST OF OPERATING A LIGHT AUTOMOBILE

The cost of operation of a light automobile used for survey work by the College of Agriculture of the University of California is shown in the following table. The automobile was purchased in July 1915 for $549.75. After running 23,790 miles, or between 35 and 40 miles per day, it was traded for a new car in April 1917, a credit of $225 being allowed, making the total depreciation, $324.75. The cost of operation was as follows:

	Total cost	Cost per mile
Gasoline	$ 275.49	$0.01158
Oil	67.04	0.00281
Storage and washing	141.40	0.00594
Repairs and overhauling	279.77	0.01176
Tires	169.51	0.00712
Miscellaneous	36.90	0.00154
Total operation	$ 970.11	$0.04077
Depreciation	324.75	0.01365
Total cost	$1,294.86	$0.05442

This apparently does not include interest on investment, which would add about $0.003 to the cost per mile, depending on the rate.

Another car used by the same division was run 32,999 miles at a total cost per mile of $0.04884, of which $0.0118 was depreciation.

Cost of making butt-welds of sheet metal by both the oxy-acetylene and the electric methods are given in a recent number of the *General Electric Review*. Labor is assumed at 30c. per hour, electrode at 5c. per lb., oxygen at 2c. per cu. ft., and acetylene at 1c. per cu. ft. For metal $\frac{1}{16}$ in. thick the cost per foot of weld is 2.12c. The corresponding cost for oxy-acetylene is 1.78c. per ft. For metal $\frac{1}{8}$ in. thick, however, the costs are 3.12c. for electric welds and 4.66c. for oxy-acetylene welds. The cost of oxy-acetylene welds continues to increase more rapidly than the cost of electric welds, until for metal $\frac{3}{8}$ in. thick, the cost is 12.3c. for electric, and 36.1c. for oxy-acetylene welds. With metal 1 in. thick, the cost of an electric weld is 61.3c. per ft., while the cost of an oxy-acetylene weld is much higher.

Automobiles in the United States during 1916 numbered 3,513,000, according to the U. S. Office of Public Roads. The number of motorcycles was 251,000. The revenue from licenses and registration-fees amounted to $25,865,000, or 42% more than was collected in 1915. About 92% of this amount was spent on highway improvement. The proportion of automobiles to population is highest in the agricultural and mining States. Iowa leads the list with one car for every 11 persons. In California the proportion is 1 to 12, Nebraska and South Dakota, 1 to 13; Kansas, 1 to 16; Montana and North Dakota, 1 to 18; Michigan, 1 to 19; Indiana and Ohio, 1 to 20; and Arizona, 1 to 21. On the other hand, New York has one automobile to 50 and Pennsylvania, one to 37 inhabitants.

COSTS OF STREET IMPROVEMENTS AT WALLA WALLA, WASHINGTON

By W. R. REHORN*

The table on the opposite page gives data regarding the street improvements completed at Walla Walla from 1909 to 1916. Considerations of space have compelled the omission of a few minor items on some of the contracts, but the costs of all the main items are given in detail.

RULES FOR SAVING FREIGHT-CARS

The following appeal is being sent to all shippers and receivers of freight by the San Francisco committee of the Car Service Commission at Washington:

"With our country at war, the railroads are being called upon to handle unprecedented quantities of all kinds of materials and supplies. They have pledged to the Government and the people their united efforts to produce minimum disturbance to commercial interests. We earnestly appeal to all shippers and receivers of freight to assist in the conservation of freight-cars, the most important considerations being the following:

Shippers. Order direct, in writing, from local representatives at point of loading only, the number and kind of cars suitable for your needs, together with the amount or weight of shipments.

Load and furnish shipping instructions in one day; the earlier in the day the better the opportunity to get car moving.

In accepting orders for shipments, secure sufficient tonnage to fill completely a 60,000, 80,000, or 100,000-lb. car, including the 10% which cars may be loaded above marked capacity.

Receivers. Place your orders in quantities to provide a full carload as above described.

In placing your orders, designate track on which cars will be loaded and bill cars accordingly.

Unload cars the day received. Quick release increases supply available for yourself and others.

The net shortage on all roads in the United States on May 1 was 145,449, which is the largest in the history of the country, with every prospect for increased demands. With 2,500,000 cars in service, this shortage can be eliminated by increasing the load per car. Loss of car-space and capacity is the most serious factor in the so-called car-shortage. A recent check of 65,219 cars shows 58% of capacity utilized.

Will each and every shipper and receiver of freight 'do his bit' in the existing emergency?

A tangent 330 miles long extends across the Nullabor plain on the East-West Transcontinental Railway of Australia. This is said to be the longest railway tangent in the world, exceeding any of those on the North American prairies.

*City engineer, Walla Walla, Washington.

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Years	Kind Of Pavement	Pavement		Excavation.		Plain Concrete Curb		Armored Concrete Curb		Concrete Combined Curb And Gutter		Armored Curb.		6 Inch Sewer.		8 Inch Sewer.		10 Inch Sewer.		12 Inch Sewer.		Inlets.		Manholes.		Catch Basins.		Contract Price.	Incidentals.
		Square Yards	Price per Square Yard.	Cubic Yards.	Price per Cubic Yard.	Lineal Feet.	Price per Lineal Foot	Lineal Feet.	Price per Lineal Foot.	Lineal Feet.	Price per Lineal Foot.	Lineal Feet.	Price per Lineal Foot.	Lineal Feet	Price per Lineal Foot.	Lineal Feet	Price per Lineal Foot	Lineal Feet.	Price per Lineal Foot.	Lineal Feet	Price per Lineal Foot.	Number.	Price.	Number.	Price	Number.	Price.		
1909-10	Sheet Asphalt	6227	$2.10	2787	$0.60	1891	$0.50	83	$0.70		$		$	224	$0.25		$	816	$0.70		$	8	$12.00		$	3	$50.00	$ 16835.10	$ 519.09
1909	" "	8185	2.10	3461	0.60	4743	0.50	320	0.70					380	0.25	1190	0.40	318	0.70			9	12.00			4	50.00	23280.47	793.75
1909-10	" "	13968	2.10	6184	0.60	6836	0.50	134	0.70					2843	0.25	1687	0.40					16	12.00			9	50.00	39273.20	490.21
"	" "	1475	2.13	470	0.65	546	0.50																					3738.25	131.25
"	" "		2.10																										
"	" "	3654	2.10	1598	0.60	1250	0.50	13	0.70																			9387.03	372.06
1910	" "	9369	200	5370	0.40	3705	0.50	70	0.70					675	0.25	156	0.40	84	0.70	1618	0.80	19	15.00	3	50.	6	50.00	25387.07	715.48
"	" "	10690	200	4540	0.60	2807	0.50	128	0.75					536	0.25	38	0.40	48	0.70	1622	1.00	14	15.00	5	50.	4	50.00	28229.55	488.00
"	" "	2896	200	1600	0.60	1680	0.50	52	0.75					270	0.25			72	0.80	850	1.00	9	15.00	2	50.	3	50.00	9113.35	355.26
"	" "	1917	200	668	0.60	1064	0.50									370	0.45					4	15.00	1	50.	2	50.00	5240.90	208.82
"	" "	5845	200	2152	0.60	1871	0.50	38	0.70							238		394	0.80			6	15.00			2	50.00	13982.18	223.79
"	" "	16049	1.97	9221	0.60	7263	0.50	407	0.70							598	0.50	1118	0.80	200	0.90	12	15.00	7	50.00	6	50.00	45200.80	903.07
1911	Concrete	534	1.50	187	0.50																							895.50	93.44
1912	"	7488	1.24	1724	0.30																							10548.73	372.32
1912-13	Dolarway.	7874	1.30	4457	0.35					5473	0.60	215	0.70	424	0.20	439	0.30	542	0.38			2	12.00	2	35.00	6	30.00	16022.71	540.44
1912	"	2607	1.30	1318	0.65					1702	0.60	985	0.80	254	0.33	26	0.42					2	12.00					5513.17	258.96
1913.	"	3190	1.30	1897	0.48					1200	0.60	187	0.75			156	0.50					1	12.00			1	40.00	7416.86	215.90
1914	Concrete.	9751	1.35	1764	0.80																							1473.76	75.13
1914.	Gravel Bitulithic	11440.5	1.48	2715	0.50	6170	0.35	673.2	0.55							874	0.55	1115	0.65			11	16.00	4	40.00	3	50.00	22568.58	456.92
1915	Asphaltic Concrete.	6850	0.98																									6713.00	382.87
"	Gravel Bitulithic.	3682.6	1.42	339.1	0.50	894.6	0.30	192	0.50							896	0.45					3	12.50	1	25.00	2	25.00	6278.97	199.13
"	Asphaltic Concrete	13491.2	0.92	415.7	0.45	6696	0.28	777	0.42							1245	0.49	2708	0.59			13	9.00	7	38.00			19077.26	769.56
"	*	1411.0	1.18			33.4	0.30	465	0.50							1533	0.45	1677	0.65			9	12.50	6	40.00			18815.47	317.15
"	Asphaltic Concrete.	3904	0.98																									3826.02	277.33
"	Gravel Bitulithic.	2273.4	1.50																									3410.10	164.40
"	" "	7554	1.42	2460	0.50	1623	0.30	946	0.55	3990.3	0.65	1861	0.90															15207.52	426.53
"	" "	1461.8	1.42	489	0.25																							2241.94	140.41
"	Asphaltic Concrete.	2820.2	1.10	2256	0.45															18" Pipe	1.25							4196.90	248.20
"	" "	5486	1.10	2220	0.45	107	0.35	120.3	0.50	3541.7	0.60					164	0.50	572	0.60			6	9.00	2	38.00			10074.75	537.30
"	Gravel Bitulithic	3479.3	1.42	880	0.30																							5364.80	228.40
1916	Bituminous Concre.	7383.2	1.00	1605	0.40			423	0.45	3410.5	0.50					238	0.50									4	35.00	10549.80	583.50
"	" "	27870.6	1.00	8380	0.40	121.6	0.30	1369.7	0.45	18732.3	0.50					2382.5	0.50	179	0.60			11	15.00	3	35.00	13	35.00	46242.01	1972.53
"	" "	10100	1.00	3825	0.40	24	0.30	512.2	0.45	6786.5	0.50					185.5	0.50					2	15.00	1	35.00	2	35.00	16689.37	823.81
"	" "	12691.2	1.00	3195	0.40	12	0.30	708	0.45	7921.6	0.50					1394.5	0.60	882	0.72			6	15.00	4	35.00	9	35.00	21902.65	998.70
"	" "	834.6	1.05																										
"	Gravel Bitulithic.	1376.5	1.29	3689	0.45			962.6	0.50	6426.5	0.55					608	0.45	76	0.55	1015	0.70	4	11.00	3	35.00	13	35.00	27816.31	1268.30
"	Bituminous.	775.5	0.95	465.3	0.40																							922.85	102.65
"	Gravel Bitulithic.	2603.8	1.29	824	0.45																							4781.50	260.25
"	" "	3307.1	1.29	1023.8	0.45			34	0.30	1954.4	0.55																	6534.00	308.61

* Gravel Bitulithic Macadam Resurface.

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Sources of Sulphur in Oils

By G. SHERBURNE ROGERS

*There are several possible sources of sulphur, though in the Californian fields sulphide waters are probably the most important. The surface and shallow ground-waters in the Californian fields carry large amounts of sodium, calcium, and magnesium sulphate, and outside of the oil-fields the deeper waters are also strongly sulphatic in character. The waters in and near the oil-measures, however, are almost or quite sulphate-free, and are usually solutions of carbonates and chlorides. Between the sulphate surface-waters and the sulphate-free waters associated with the oil, every gradation may be found; and near the horizon at which sulphate begins to decrease and carbonate to increase the waters usually contain hydrogen sulphide. As sulphate is abundant in the shallower waters everywhere along the Californian coast ranges, whereas sulphide is found only in the oilfields and near the oil and gas, it is reasonable to suppose that the sulphide has been formed through the reduction of sulphate by the hydrocarbons. The reaction supposed to be involved is usually written:

$$CaSO_4 + CH_4 = CaS + CO_2 + 2H_2O = CaCO_3 + H_2S + H_2O$$

Although the field evidence in favor of some such reaction is strong it must be admitted that it has apparently never been experimentally proved. In any event the reaction as written can be considered only as a condensed representation of the type of change that takes place, the intermediate stages in the decomposition of the hydrocarbons on the one hand and of the sulphate on the other being as yet unknown.

In some regions gypsum may be disseminated through the strata near the oil-measures and if taken into solution and carried to the oil may be reduced to sulphide. This is, of course, essentially the same as the reduction of sulphate surface-waters. Gypsum in the anhydrous condition, however, is a very stable compound, and even with an active reducing agent, such as carbon monoxide, a temperature of about 700° C. is required for its reduction. Whether the reduction of sulphate by hydrocarbons takes place or not, it is certain that many of the oilfield waters carry hydrogen sulphide or alkaline sulphide in amounts ranging up to more than 300 parts per million. The tendency of alkaline sulphide to become free H_2S, and the tendency of this gas to oxidize to sulphur, are well known. In this connection the following personal communication from Clifford Richardson is of interest: "Some years ago I collected in a sealed tube 200 or 300 cc. of a natural gas in Trinidad which contained hydrogen sulphide. This was allowed to stand for about ten years without observation, but at the end of that time it was found that the sulphur of the H_2S was deposited on the walls of the tube in colorless crystals." The oxidation of hydrogen sulphide proceeds even under very feebly oxidizing conditions, as on the floor of the ocean, and it doubtless takes place even in deeply buried strata. In the light of other corroborative evidence, it seems probable that considerable amounts of hydrogen sulphide are oxidized to sulphur, which is precipitated. As the strata directly above the oil-measures have not been tested for sulphur, this supposition cannot be definitely proved, but it is significant that small deposits of disseminated sulphur are not uncommon along the western edges of the Coalinga and Midway-Sunset fields. Moreover, a commercial deposit of sulphur has been found near the southern end of the Sunset field, in the same formation that contains the oil-measures in the field nearby. An interesting feature of this sulphur, to which my attention was first directed by E. A. Starke of the Standard Oil Co., is its intimate mixture with material containing hydrocarbon, which seems to constitute 20% or more of the amorphous substance.

It may be added that the waters associated with the oil in many regions are known to be free from sulphate. In many fields there are strong chloride waters which doubtless represent the sea-water entrapped in the sediments when they were laid down, and which therefore never contained a large concentration of sulphate; but in some fields the low chloride and the high carbonate indicate that the waters are in part altered meteoric waters from which considerable quantities of sulphate have been removed. In some Tertiary and Cretaceous fields in which the normal surface-waters are strongly sulphate in character the reduction of the sulphate by the stages outlined above may afford abundant supplies of sulphur to react with the oil. Hence, as meteoric waters carry oxygen and also salts that eventually yield sulphur, it is probable that in many regions waters are the chief agents in the alteration of the oil. The apparent increase in the gravity of oil that has been associated with certain types of water is recognized by many practical oil men.

As pyrite is said to react with and to yield sulphur to petroleum it is probable that in some localities the action of both pyrite and its less stable isomer, marcasite, have been important. These minerals have been found in many wells in the Californian fields. They probably formed in part during the deposition of the sediments, through the reducing action of organic matter on iron-sulphate solutions; but they may also have originated later through the direct action of hydrogen sulphide on chalybeate waters. J. J. Hern, a Californian oil man of wide experience, told me that in wells in which large

*Abstract: Trans. A. I. M. E., St. Louis meeting, 1917.

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quantities of iron sulphide are found the oil below is likely to be abnormally warm. If this observation is well founded, it may be significant as indicating chemical reaction between the sulphide and the oil. In some regions sulphur is doubtless derived from still other sources. Hydrogen sulphide and sulphur di-oxide are common components of volcanic emanations, and the former is found in many thermal springs supposed to represent the last stages of igneous activity. Much of the Mexican oil, which is heavy, asphaltic, and high in sulphur, is found near igneous intrusions and may well have been affected by the sulphurous gases that doubtless accompanied them. The oil in the salt-domes of the Gulf Coast is somewhat similar in character and has evidently been altered by sulphur, but the origin of the sulphur in this case is related to that of the salt-domes themselves, and has never been satisfactorily explained. Again, it has long been known that some varieties of bacteria have the property of generating hydrogen sulphide through the reduction of sulphate solutions. Some of these bacteria are anærobic, being able to exist in the absence of air, and their action has been repeatedly observed in ocean water, but whether they can exist and function in deeply buried strata is open to question. Finally, there are oils, like those of the Appalachian fields, that have apparently never been subjected to the action of sulphur; and others, like the Trenton limestone oil of Ohio, that are generally supposed to owe their sulphur to the character of the organic remains from which they were formed. If the organic origin of petroleum is accepted the old idea that the contained sulphur indicates derivation from animal remains is not necessarily valid. It is generally recognized, however, that the character of the original organic material has a bearing on the composition of the oil derived from it.

FINANCES OF AMERICAN CITIES

In 149 of the 213 American cities of more than 30,000 population the excess of expenditures for governmental costs, including interest and outlays for permanent improvements, over revenues during the fiscal year 1916 amounted to $86,013,326, or $3.68 per capita. In the remaining 64 cities the excess of revenues over expenditures was $12,422,256, or $1.40 per capita. Taking the entire 213 cities as a group, the excess of expenditures over revenues amounted to $73,591,070, or $2.28 per capita. The net indebtedness of these cities averaged $76.64 per capita, a figure nearly eight times as great as the corresponding one for the National Government. Eighty-nine cities, or nearly 42% of the total number, are operating under the commission form of government.

Passenger-trains representing 16,367,028 train-miles per year have been eliminated by the railways of the country in order to facilitate transportation of freight during the War. It is estimated that this reduction will release 1,120,000 tons coal for other uses.

MAINTENANCE OF CONCRETE HIGHWAYS IN MILWAUKEE COUNTY, WISCONSIN*

In 1916 about 1,000,000 sq. yd. of road surface was maintained at an expense of $5269.91, which included labor, materials, and machinery-depreciation. Of this amount, 923,483 sq. yd. was concrete, on which $4051.62 was expended or about $0.0044 per sq. yd. There was also expended about $18,000 on shoulder-work, ditches, sewers, retaining-walls, and other miscellaneous items. No part of this sum is chargeable to road-surfacing.

Since 1912 the total cost of maintaining concrete-road surfaces was $10,721.85. Of this amount $4822.82 was expended on 43,482 sq. yd. of surfacing that was not built according to modern methods.

Our method of repairing concrete highways is as follows: The surface should be first swept with a steel broom to loosen any dirt, after this the spot should be thoroughly swept with fibre street-brooms. To remove the fine dust which the steel brooms leave behind we use ordinary house-brooms, which leave the surface in fairly clean condition.

The depression is then covered with hot tarvia No. 9 and filled with coarse sand or screenings and opened to traffic. In case the depression is of considerable depth, or what might be called a hole, we would advise one of two methods: First (in case you want to avoid delaying traffic), clean the depression as already described, and then paint it with tar. Then bring the surface to grade with crushed stone, being careful to have the greatest dimension of the stone less than the depth of the depression. Tamp the stone in place with hand-tampers or roll with a roller, if one is available, and fill the voids with a heavy bituminous road-binder, allowing about one gallon per square yard per inch in depth. The second method is to cut out the poor place and after trimming the hole and sprinkling the sides, fill with the same mixture as was used in the original road.

We consider it economy to have a small maintenance-crew which goes once or twice each year over all the roads in the county. Such a crew consists of a foreman, one team, and four laborers. Under average conditions, this crew will cover the joints, cracks, and small pits in from one to two miles of 18-ft. road in one day at a cost of from $15 to $30 per mile for labor and materials.

Trained organizations in highway work demonstrated their value once more when it became necessary that a road should be constructed without delay to one of the new military cantonments. Labor was scarce, but it happened that the State Highway Commission had at its command a large number of convicts who were already experienced in such work. These men were sent to the job at once and completed the work under the direction of foremen in the employ of the commission. The cost of the work was also considerably less than if it had been done by contract.

*Extract from the fifth annual report of H. J. Kuelling, county highway commissioner, Milwaukee, Wisconsin.

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Specifications for Gasoline for Internal-Combustion Engines

The U. S. Bureau of Mines has issued Technical Paper No. 166, 'Motor Gasoline, Properties, Laboratory Methods of Testing, and Practical Specifications,' by E. W. Dean, containing the recommendations of the Bureau on a recent investigation. An abstract of the report follows:

Desirable Properties of Gasoline

The essentially desirable properties of gasoline may be summarized briefly as follows:

(1) The gasoline should not contain too large a proportion of highly volatile products, which tend to cause large evaporation losses and danger in handling and storage, but should have sufficient volatile constituents to permit starting an engine under somewhat unfavorable conditions without pre-heating.

(2) The gasoline should not contain any considerable amounts of heavy or non-volatile constituents, which after atomization into the engine-cylinders cannot be completely vaporized and burned.

(3) The gasoline should not contain a material which after combustion leaves a residue that collects in the motor.

(4) The gasoline should be free from substances that attack metal, either before or after combustion. Unremoved acid (used in refining) falls under this head.

(5) Neither the gasoline nor its products of combustion should have a strong or markedly disagreeable odor, because of this being objectionable to users of automobiles.

(6) The gasoline should be free from non-combustible material, such as water, sediment, acid, etc.

These stated requirements are simple in principle and are almost axiomatic. The chief problem is to fix limits, defined by actual tests, that will satisfy the desirable conditions.

Types of Gasoline Marketed and Their General Properties

There are at present on the market types of gasoline produced by several general methods. These conditions may be classified as follows:

1. 'Straight' refinery gasoline.
2. Blended casing-head gasoline.
3. Cracked and blended gasoline.

'Straight' Refinery Gasoline. These are produced by methods that vary somewhat in different parts of the country but in general are similar. Crude oil is distilled in a fire-still and a 'cut' made when the gravity of the product reaches some pre-determined mark. So-called crude naphtha, or benzene, is acid-refined and steam-distilled. Several products of different ranges of volatility may be produced, or the steam-distillation may simply separate the product from the less volatile bottoms, which go into the burning-oil stock. 'Straight' refinery gasolines are generally characterized by a low content of unsaturated and aromatic hydro-carbons, and by a distillation-range free from marked irregularities.

Blended Casing-Head Gasoline. During the past few years so-called casing-head gasoline, obtained from natural gas by compression or absorption, has come on the market. 'Straight' casing-head gasoline is too volatile for general use and is generally blended before being marketed with enough heavy naphtha to produce a mixture that can be used safely and is moderately cheap. In general, blended casing-head gasoline is characterized by a volatility-range that shows a considerable proportion of constituents of low and of high boiling points, but a lack of intermediate products. Frequently, however, the blending is done in a manner difficult to detect, the natural-gas gasoline being used in moderately small proportion with 'heavy' straight-run naphtha in order to make a product having a desirable proportion of volatile constituents. As regards its chemical properties, blended casing-head gasoline seems to be identical with the 'straight' refinery product of the same distillation-range. Characteristic physical properties of blended gasoline are caused by the details of blending.

Cracked or Synthetic Gasoline. Important factors in the present supply of gasoline on the market are the cracked or synthetic gasolines. These are being marketed in large quantities, mainly, if not entirely, in the form of blends with 'straight' refinery and casing-head gasoline.

Cracked gasolines are similar to 'straight' refinery products in most physical and chemical properties, but differ chemically in containing varying proportions of unsaturated and aromatic hydro-carbons. It has been demonstrated that these constituents, if present in moderate proportion, do not decrease the value of a gasoline. Also, competent authorities generally concede that by proper engine-equipment and adjustment it is possible to use unsaturated hydro-carbons in practically unlimited proportion, although conclusive experimental proof of this latter point is not available as yet.

Calorific Power, or Heating Value. No data are at hand to show the effects of calorific power on the usefulness of a gasoline. However, the actual variations in calorific power for different kinds of gasoline seem to be relatively small, and as the mechanical energy developed in the engine is only a fraction of the heat produced, these variations may be regarded as negligible. Some recent experiments have shown that gaso-

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lines of widely differing physical properties varied only by a maximum of 2% in calorific value per unit weight.

Content of Aromatic Hydro-carbons—Benzol, Toluol, and Others. At present little heed need be given to the effect of aromatic hydro-carbons in motor fuel, as these products are in demand for the manufacture of explosives, dye-stuffs, and drugs. After the end of the War in Europe it may become necessary to devise a specification-clause limiting the proportion of these hydro-carbons that a gasoline may contain, but such action may be unnecessary, for present indications are that aromatic hydro-carbons are just as good motor fuel as non-aromatic. If limitation should become necessary it can probably be made most effectively and simply through the specific-gravity requirements. Aromatic hydro-carbons—benzol, toluol, and the others—have specific gravities of about 0.87 to 0.88 (29° to 30° Baumé) and boil at the same temperatures as non-aromatics having specific gravities between 0.70 and 0.76 (54° to 70° Baumé).

Unsaturated Hydro-carbons. The effect of unsaturated hydro-carbons on the properties of gasoline is another matter that is not thoroughly understood. As already stated, there is conclusive evidence showing that gasolines containing moderate amounts of unsaturated hydro-carbons can be used with entire satisfaction, but it is not yet definitely established that the presence of unlimited proportions of these constituents causes no disadvantage. In view of present market conditions it does not seem desirable to emphasize any requirements that may interfere with the development of cracking processes, as these now seem to be the greatest factor in conserving the country's petroleum resources.

Specific Gravity. This in itself is of slight significance in determining the properties of gasoline. It may serve as an index of other properties, particularly volatility, if knowledge is at hand regarding the source and method of production of a gasoline. The determination of gravity has been and probably always will be one of the most useful tests that the refiner employs, but it is of but little value to the analyst who does not possess sufficient additional information to make proper interpretation of gravity-results.

Volatility. This is the basic property that determines the grade and usefulness of a gasoline. Unfortunately its influence is not simple enough for adequate discussion in a few words, chiefly because the advantages and disadvantages of various characteristics of volatility are so balanced that no one characteristic can be said to be either entirely desirable or entirely undesirable. For example, the presence of a considerable amount of low-boiling constituents in gasoline would seem desirable in that they permit easy starting of a cold engine. Against this advantage are the high prices of such gasolines and the considerable evaporation losses, the latter tending to increase danger in storage and handling.

Gasoline should contain a moderate proportion of low-boiling constituents, enough to permit easy starting of a cold engine but not enough to make evaporation losses excessive. It should have a total volatility-range wide enough to include constituents that have a high, but not too high, boiling-point. For economic reasons affecting both the individual user and the country as a whole, this volatility-range should be such that the gasoline contains the largest possible proportion of the original crude oil. It should not, however, be wide enough to exceed the limits of the vaporizing power of the automobile-engine.

Limits and Requirements of Gasoline Specifications. An ideal system of specifications would, by a minimum of simple requirements, eliminate all unsatisfactory products without discriminating against any that are desirable. This ideal is, of course, impossible of attainment for gasoline, partly because no hard and fast line differentiates good gasoline from bad, and partly because a satisfactory simple specification cannot cover all possible sources of discrepancy. In general, however, the tests discussed later furnish an adequate index of quality for the normal products marketed as gasoline, and will probably be satisfactory until such time as new and unforeseen developments occur in the refining industry.

The requirements which are considered adequate for the present are color, freedom from acidity, and volatility. Color in itself is of minor importance, but generally, though not infallibly, indicates whether or not a gasoline is properly refined. At present, producers show little tendency to market gasolines that do not meet requirements in this respect. The requirement of freedom from acid is important, and the simple test should always be made, even though the almost universal care taken by refiners has made is practically unnecessary.

In discussing volatility requirements it has been inadvisable to state definite figures, as it is possible that undue importance may be attached to the limits mentioned. Only one definite temperature-limit is stated, that which prevents a gasoline from having too high a proportion of volatile constituents. This limit is one which for commercial conditions is not likely to be passed, but it is included to make possible the rejection of gasoline that obviously is unfit to store or handle. Other temperature-limits are left indeterminate or else given in relative terms.

The two limits upon which most emphasis is laid are the temperatures below which 20% and 90% of the gasoline should distill. Any two other percentage marks near the initial and the upper end of the distillation range might serve, but these two points are the most satisfactory for determination by the analyst, and it is thought are at least as important as any others with regard to the behavior of the gasoline in the motor. A tolerance is allowed for each limit, on the assumption that a moderate discrepancy in one does no harm if the other is at least an equal amount below

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the required mark. However, the compensation is limited to variations not exceeding 10°C. (18°F.).

A limit for the 50% mark is fixed not because it will ordinarily be of significance, but because it will tend to prevent the marketing of 'freak' naphthas that might prove unsatisfactory. The requirement that the 'dry point,' or highest temperature read on the thermometer after the distilling flask goes dry, shall not exceed the 90% temperature by more than 55°C. (99°F.) is liberal, but is sufficient to discriminate against improperly distilled gasolines and unsatisfactory blends of gasoline and kerosene.

A lower limit of 70°C. (158°F.) is placed on the 20% mark, this also being of importance only with possible 'freak' gasolines. It is, however, a limitation that has a sound and practical basis, as such gasolines are subject to serious evaporation losses.

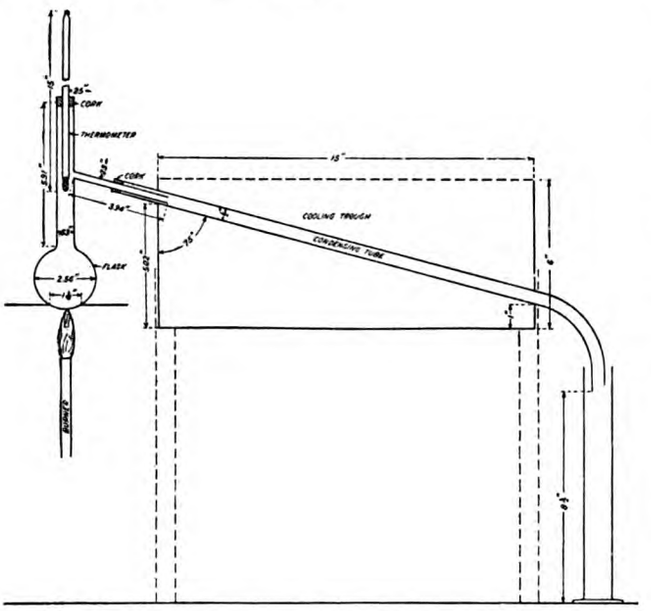

PLATE I. APPARATUS FOR DISTILLATION-TESTS

Proposed Specifications for Motor Gasoline

Color

Requirement. Water-white.

Methods of determination. Inspection of column in 4-ounce sample-bottle.

Acidity

Requirement. Total absence.

Methods of determination. Ten cubic centimetres of the gasoline is to be shaken thoroughly with 5 cc. of distilled water. The aqueous extract must not color blue litmus-paper pink.

Volatility

Requirements. The gasoline shall, when distilled by the method described hereafter, meet the following requirements:

(*a*) The temperature read on the thermometer when 20% has distilled shall not be below 70°C. (158°F.) nor above whatever limit is fixed after due consideration of conditions of use.

(*b*) The temperature read when 90% has distilled shall not be above another limit similarly chosen.

(*c*) The temperature read when 50% has distilled shall not be higher than a mark half way between the 20% and the 90% limit.

(*d*) The dry point shall not exceed the 90% reading by more than 55°C. (99°F.).

Tolerance. If either the 20% or the 90% temperature mark is above the required limit by an amount not exceeding 10°C. (18°F.), the gasoline may be considered acceptable if the sum of the two temperatures read for the 20 and the 90% marks do not exceed the sum of the adopted limits.

Distillation Method and Apparatus

The distillation method prescribed is approximately that recomended by Subcommittee XI of Committee D_1 of the American Society for Testing Materials.

The two noticeable points of variation are the method of reading temperatures against fixed percentage points and the use of a thermometer of lower range. The method of the American Society for Testing Materials is proposed for the analyses of turpentine substitutes, which are petroleum products of higher boiling range than gasolines.

The apparatus used in the distillation should be as follows (see Plate I):

Flask. The flask used shall be the standard 100 cc. Engler flask. It shall be suported on a ring of asbestos having a circular opening 1¼ inches in diameter; this means that only this limited portion of the flask is to be heated. The use of a sand bath is not approved.

Condenser. The condenser shall consist of a thin-walled tube of metal (brass or copper), ½ in. internal diameter and 22 in. long. It shall be set at an angle of 75° from the perpendicular and shall be surrounded with a water jacket of the trough type. The lower end of the condenser shall be cut off at an acute angle and shall be curved down for a length of 3 inches. The condenser-jacket shall be 15 in. long.

Thermometer. The thermometer should be made of selected enamel-backed tubing, having a diameter between 5.5 and 7 mm. The bulb should be of Jena normal or Corning normal glass; its diameter shall be less than that of the stem and its length between 10 and 15 mm. The total length of the thermometer should be approximately 380 mm. The range should cover 0° to 270°C., with the graduated portion between 210 and 250 mm. long. The point marking a temperature of 35°C. should be not less than 100 nor more than 120 mm. from the top of the bulb.

The scale should be graduated for total immersion. The accuracy must be within about 0.5° C. The space above the meniscus must be filled with an inert gas, such as nitrogen. The stem and bulb must be thoroughly aged and annealed before being graduated.

Method of Distillation. The flask connected with the condenser shall be filled with a 100-cc. charge of gasoline, which shall be measured from a 100-cc. graduated

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cylinder. The same cylinder may be used without drying as the receiving vessel for the distillate. Heat shall be applied to the flask in regulated degree, care being taken that the whole distillation from beginning to end shall proceed at a rate of not less than 4 nor more than 5 cc. per minute. Reading of the thermometer shall be made as each 10% distills.

The dry point or highest temperature reading at the end of the distillation shall also be recorded. The distillation-loss shall be determined by adding the percentage of residue in the distilling-flask, after cooling, to the percentage of total distillates held in the receiver. If the distillation-loss is over 3%, a check-distillation shall be made, as excessive loss may indicate that the rate of distillation at the beginning was too rapid. In case the magnitude of the loss is confirmed this fact is of importance in indicating that the gasoline contains very volatile constituents, particularly those derived from casing-head gasoline.

The condenser-trough shall be filled with a mixture of cracked ice and water (not dry cracked ice), and during the distillation sufficient ice shall be kept in the trough to prevent the temperature of the cooling water exceeding 8°C. (46°F.).

If distillations are made at high altitudes or when barometric pressures are low, allowances may be made for this factor. In general, recording the barometric pressure read at the time of the distillation will suffice and it is recommended that this should be done whenever there is possibility of dispute over the results of a distillation.

The thermometer-bulb should be covered with a thin film of absorbent cotton; this keeps the glass wet with the condensate from the vapor and thus prevents possible fluctuations in the temperature. It also tends to prevent superheating of the bulb at the end of the distillation and thus makes possible an accurate determination of the dry point.

The whole procedure is relatively simple but requires care in manipulation. The use of apparatus at least approximately as described is essential, although the method is such that no considerable discrepancies will result if the apparatus is not exactly standard. The chief source of difficulty is the rate of heating. It is desirable to bring the initial charge up to the boiling-point as rapidly as possible in order not to waste time, but unless care is taken, the distillation will start too rapidly and there will be losses in the form of uncondensed vapor. In consequence the actual percentages will be higher than those observed and the temperatures may likewise be noticeably high. If, however, the distillation-loss is not permitted to exceed the stated amount this difficulty can be avoided. In case the gasoline to be tested contains considerable proportions of constituents difficult to condense, the condenser-trough may be filled with a freezing-mixture and the receiver also kept cooled. If this is done, it is desirable to measure the original charge at the temperature of this freezing-mixture.

ACCOUNTING SYSTEM ON GOVERNMENT CONTRACTS

The cost-accounting work initiated by the Federal Trade Commission has been taken over by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, and a new division has been organized to assist those departments of the Government that have important contracts to let and may not have adequate staffs to investigate promptly the cost of manufacturing the articles they wish to purchase. That will be the first task of the new division, although the establishment of uniform systems of cost accounting in the different industries is the ultimate object sought.

Mr. J. Lee Nicholson, head of a well-known accountancy firm in New York, has been placed in charge of the division. He outlines the proposed activities as follows:

The Division of Cost Accounts, of course, is designed to carry on the work undertaken by the Federal Trade Commission, which was largely educational and aimed at a widespread adoption of uniform efficient cost-accounting systems. But just at present the most pressing and important task is to establish a consultation service for the benefit of all Government departments that are making or planning extensive purchases, and are not equipped to investigate manufacturing costs.

We expect to meet with manufacturing groups, irrespective of any particular trade association. Such meetings will be held at various central points throughout the country, and will include the groups of manufacturers who are now interested, or who may be interested in the future, in Government contracts. To these manufacturers will be presented the methods to be followed in stating their costs to the Government. This term "methods" includes the manner in which the classification of their costs should be stated. The object of this is to save the manufacturer both trouble and expense and reduce mistakes to the minimum. The further object also is to save the Government considerable expense in checking the correctness of bills rendered by the manufacturer and to secure the protection for the Government which the interests of the public require.

Of course, it is presumed that the Government will inspect all cost figures contained in the bill rendered by the manufacturer and it is also presumed that the manufacturer may feel called upon to engage the services of auditors in case of dispute. In some cases it may be necessary to conduct an investigation for the purpose of preparing financial cost schedules. However, if there is a fair understanding of all these matters before the contracts are distributed it certainly will save both the manufacturer and the Government considerable expense in checking up the cost figures. If cost schedules are not properly prepared it takes weeks to do something which ought to be done in a few days. The work of the new division will insure that costs can be supervised by those who have no private interests in the work of supervising but who are public servants working solely in the public behalf.

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Industrial Progress

HYDRAULIC PRESSURE TESTS OF OXY-ACETYLENE WELDED AND SCREWED PIPE CONNECTIONS

*The interest created by an article that appeared about a year ago giving a report of tests of oxy-acetylene welded pipe connections and screwed pipe connections tested under tension and compression, and the desire of readers for further information regarding the relative strength of welded and screwed pipe connections, encouraged the experimenters to carry on a second series of tests.

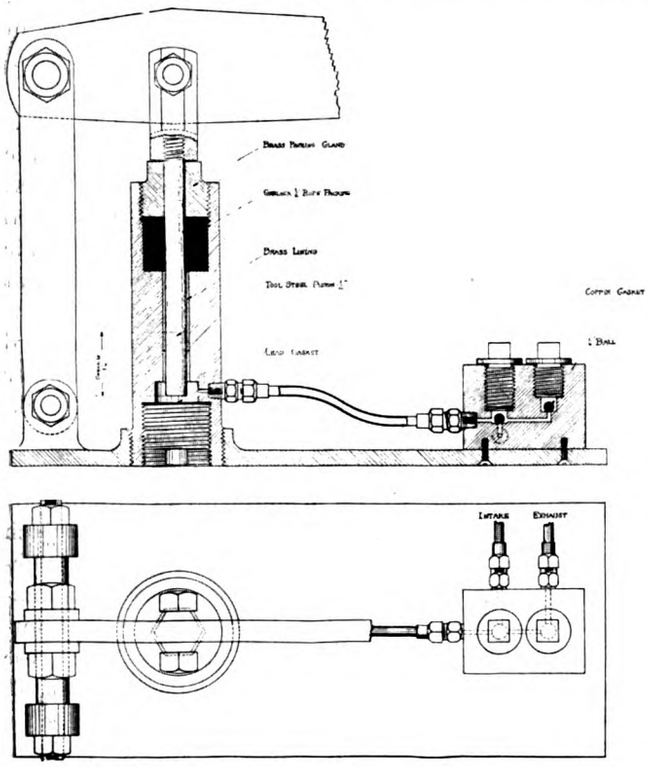


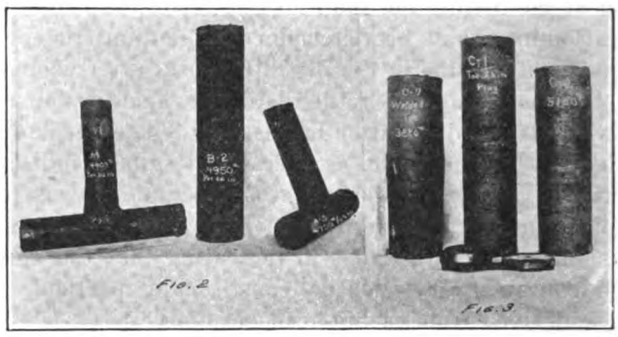
Fig. 1

These tests were conducted in the machine-construction laboratory of the University of Kansas and had for their purpose the determination of the relative strength of welded and screwed connections in steel pipe of various sizes when subjected to internal hydraulic pressure.

The pipe samples, which were cut from standard black steel pipe, were from the same stock and hence probably of uniform quality. The welded specimens were made by operators of the Oxweld Acetylene Co., Chicago. The screwed connections were made up with malleable-iron couplings and tees by expert pipe fitters. The pieces for the butt welds were cut at an angle of about 60° in a pipe-cutting machine to get the necessary 'V' groove for welding. The 'T' welds were made by cutting a hole in the run and butting the outlet against the run. The ends of all the specimens were sealed by welding in plugs or discs made from boiler plate punchings. Two of these discs are shown at the bottom of Fig. 3.

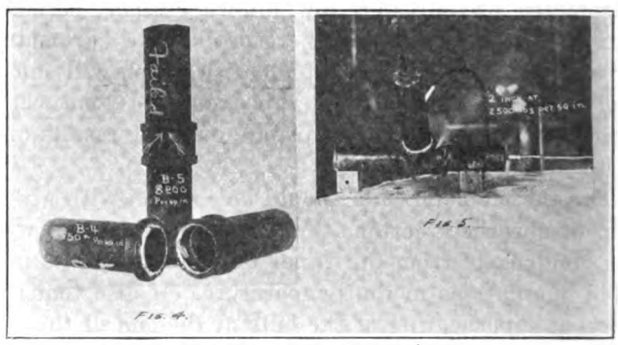
The specimens were subjected to pressure by means of a small hydraulic pressure pump, Fig. 1, which was made especially for this work. The specimen under test was placed about 25 ft. from the pump and connected to it by means of a ½-in. copper tube. A pressure-gage with a check-valve opening toward the gage was placed between the pump and the specimen. The check-valve was necessary to steady the pressure in order that satisfactory readings could be obtained because some of the samples carried pressures greater than 5000 lb. per sq. in. before failing. The illustrations show several of the specimens tested and their modes of failure.

Welded 2 and 3-in. specimens are shown in Fig. 2. These



failed by splitting along the longitudinal seams of the pipe, the split stopping at the welded section. The 4-in. welded specimens in Fig. 3 bulged under the high pressure but did not fail in either the weld or the pipe-seam.

The mode of failure of two of the screwed connections are shown in Fig. 4. The bursting pressures for the screwed



connections were far below that of the welded specimens and all failed in the fitting. Great difficulty was experienced in testing the specimens made up with screwed fittings because sand-holes developed and the water leaked through the castings to such an extent that it was almost impossible to reach the point of rupture. Fig. 5 shows one of the screwed 'T' specimens under test and illustrates clearly the leaky condition just mentioned.

Examination of the data given in the table shows that in only one case was there failure in the weld and that was merely a leak which did not develop until 3850 lb. per sq. in. pressure was applied. This brings out the point that while leaks are much less likely to occur in welded than in screwed connections they are the principal cause of difficulty. Therefore, pipe-lines that are to be subjected to high pressure, if properly tested for leaks when installed, should give no trouble under service.

The results of these tests bear out the conclusions given in the previous series, namely:

a. The strength of a welded pipe connection is practically the same as that of unwelded pipe. By building up the weld slightly it can be made stronger than the rest of the pipe.

b. The strength of the welded pipe connection is very much greater than that of the malleable-iron screwed fittings.

c. Although a careless or inexperienced operator might produce a leaky joint, nevertheless, if the pipe-line is tested for leaks when installed it should give no difficulty in service.

*F. H. Sibley, Professor of Mechanical Engineering, University of Kansas, assisted by Messrs. Maris, Ruth, Schooley, Jesperson, and Dryden.

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EDITORIAL

CEMENT-TESTING work formerly done by the United States Reclamation Service has been taken over by the United States Bureau of Standards.

A TYPOGRAPHICAL error appears on page 264 of our July issue near the middle of the second column. The numerator in the equation should be 104.7 instead of 194.7.

AN echo from the past is found in the sale of the Mono Lake & Bodie railroad. This line was built in 1881 by the Mono Lake Lumber Company, but has not been operated for a number of years. In spite of the fact that the rails and rolling-stock had all to be hauled more than fifty miles over mountain roads, the present high prices for old metals have made the transaction profitable.

THE city-manager plan has proved to be a success in San Rafael, California. An exhaustive comparison by a firm of public accountants of the two years preceding and the two years following the appointment of Mr. F. J. Boland as city manager shows a saving of over $1300 in items that can be directly compared. This takes no account of the fact that the work was probably done better as well as cheaper.

GASOLINE prices from 20 to 25 cents per gallon are considered high by American consumers, but in England the ruling price is now about 60 cents per gallon. This has caused automobile owners to make experiments with coal-gas as a substitute. The changes required in the motor are small but the size of the container required for the gas, even after it has been compressed considerably, is a drawback. There is, however, a reduction of at least 50% in the cost of fuel per mile.

REINFORCED concrete ships are soon to be built by a firm of San Francisco engineers. It is stated that the plans call for a vessel 330 feet long, with a 44-foot beam, and a depth of 31 feet. Several concrete barges have been built at different times for use at the Panama Canal, Chesapeake bay, and in Norway. They have given good service and there is every reason to suppose that larger vessels could be constructed that would also be satisfactory.

THE Shipping Board dispute has been solved by President Wilson in what was probably the only logical or possible way. General Goethals and Mr. Denman are both excellent and patriotic citizens but it has become evident that they cannot work in harmony, and that they can both serve their country better in some other capacity. The delay in the shipbuilding programme that has resulted from the disagreement is regrettable but that is now a thing of the past. It only remains for us to give the new appointees our best wishes and our cordial support.

A NEW contracting company appeared in California a few months ago and startled engineers and contractors alike by obtaining several contracts at prices considerably below the next lowest bid and, in most cases, considerably below the engineer's estimate. It might also be stated that the members of the company had had more experience in other lines of business than in contracting. A few days ago the company filed a voluntary petition in bankruptcy. We were going to write quite an article about this, but all things considered it is not necessary. Our individual readers can do that.

A RECONNAISSANCE of the Feather River Canyon route for the California State Highway lateral between Oroville and Quincy is to be made by a committee composed of a representative from the State Highway Commission together with the county surveyors of Butte and Plumas counties. As most of our readers remember, the question is between the more expensive canyon route, which would be at a comparatively low elevation and would be open to traffic during most of the winter, and a cheaper highway along the ridges, which would be closed by snow from four to six months every year.

BIDDING much lower on a job than anyone else is often taken as an indication that the contractor making such an offer either does not know his business or that he hopes to obtain some unfair advantage over the other bidders. It sometimes happens, however, that the real reason for the difference is that the man who names the low figure has worked out a method for doing the work more efficiently than by the traditional way that may have been assumed by the other bidders. Mr. H. L. Tilley's article on the construction of the Shoal Lake dike appearing in another column shows how a contractor with originality bid $95,000 on a job where the next lowest bid was $125,000 and still was able to reap a substantial profit.

AN important legal decision regarding the liability of public officials for damages resulting from defective public highways was recently rendered by Judge J. A. Bardin in the case of J. A. Phippen *v.* the Board of Supervisors of San Benito county. Winter storms had destroyed a bridge on a county highway. Before a new

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bridge was constructed the plaintiff drove his automobile off the old embankment and sustained serious injuries. The testimony showed that there were warning signals and an obstruction in the highway about fifty feet from the bridge. The judge decided that either the plaintiff was not driving with due care or else that the brakes were not in good condition, and that the county was not liable for damages.

ENLISTMENT for military service on the part of undergraduate engineers is being discussed considerably in this country. In this connection it is interesting to note that this has been carried on in Great Britain to such an extent that there are practically no third and fourth-year technical students left. In view of the need of technical training for the industrial competition that is sure to follow the end of the War, this condition is rightly considered to be a subject for alarm, and steps to encourage the first and second-year students now in the colleges to remain at their studies are being advocated. The encouragement of enlistment by student-engineers was a natural and pardonable mistake in Great Britain at the beginning of the War. For the United States to repeat this mistake in the light of subsequent events would be inexcusable.

ADDITIONAL engineer units, about 25 regiments in all, have been authorized by the War Department. These troops are in addition to the 9 regiments already recruited, and with them will have charge of engineering operations behind the lines, including railway construction and operation, water-supply, and forestry. They will be mobilized at the divisional cantonments. Officers will be taken from the engineer officers' training camps and the engineer officers' reserve.

The California Petroleum Situation

In another column appears an abstract of the report of the committee appointed to investigate the petroleum situation for the California State Council of Defense. Probably the most significant feature of the report lies in the recommendations regarding the opening of withdrawn lands and other oil lands in litigation to development. It is hardly necessary to call attention to the fact that the integrity and impartiality of the members of the committee is beyond question, or that the personal interest of any of the members in the oil companies affected, if anything, is slight. Nevertheless the findings of the committee are in direct opposition to most of the statements of certain Federal officials who have so far been able to block all legislation for the relief of the Californian oil-operators, and are in substantial agreement with the recommendations made by various representative oil-men who have been denounced by those same officials as thieves. The committee states that it is probable that Californian and Pacific Coast consumers in general will not have enough oil for their actual needs in a few months unless the Federal Government takes steps that will permit the development of at least part of the lands now in litigation. These steps should be taken immediately. Wells in the more productive parts of the Californian fields take several months to drill. It will not do to wait until the tanks and reservoirs are empty and then commence a frantic drilling campaign. Whether or not the Navy is going to need oil in '1920-something' has always been a matter of dispute. It has now become a purely academic question. The industries of the country, upon whose efficiency and prosperity success in the War depends, need oil now.

Competitive Bids for Furnishing Engineering Services

In another column appear letters from two structural engineers regarding a call for bids for furnishing plans and specifications for several bridges. In considering this matter it must be remembered, as our correspondents point out, that the county officials are in no way to blame for selecting this method of obtaining plans since the county charter allows them no discretion in such cases.

The principal drawbacks to this method of selecting engineers to prepare plans are shown by our correspondents. These arguments also apply to most other cases where engineers are invited to compete with each other. The broader question of the advisability of incorporating in constitutions and charters, provisions that limit unreasonably the power and therefore the responsibility of governing bodies should also be considered. A hundred years ago the idea of 'checks and balances' was uppermost in the minds of framers of constitutions. In order to prevent officials from doing wrong, they made it difficult for them to do anything at all. This idea is present in the Federal Constitution and runs riot in some State constitutions. That it still lives is shown by the fact that the Tehama County charter was adopted only two years ago.

The present tendency, however, is away from this conception of government, and toward the selection of officials with wide powers but who are held to strict accountability if they misuse them. This is particularly exemplified in the city-manager plan. As a general rule we believe that the most capable public officials at the present time are those with the widest powers, and that they are also the ones that have the greatest share of the public confidence. In the present instance, it is probable that the framers of the Tehama County charter inserted the provision regarding bridge-plans simply because they believed that this method would result in better service to the community and the elimination of graft. As a matter of fact, far better results could have been obtained if they had allowed the people to elect really responsible supervisors who could use discretion in this and other questions, or better still, leave such administrative questions in the hands of a county manager, subject to the approval of the Board of Supervisors for such matters as the final award of the construction-contract.

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REVIEW OF THE MONTH

WAR continues, as it should, to be the main interest and business of the American people. The drawing of the draft-numbers has been completed and both corporations and individuals are now able to form an approximate idea as to how they will be affected. Work is plentiful now, but will be even more plentiful after the drafted army has been called to the colors. We may reasonably expect an increased use of female labor such as has been the case in the other belligerent countries. The Southern Pacific Company, in particular, some months ago started a school for training women to be station-agents. The first student has recently been graduated after two months training. At that she is likely to be a better agent than some of those of the other sex that we have met. No, we do not know the name of the station to which she has been assigned.

'DILUTION' of labor in Great Britain means the employment of as much unskilled labor, particularly women, in a factory or elsewhere as can possibly be used, leaving the skilled workers to do only the work that the unskilled workers cannot learn to do in the time that is available. Since it is probable that some 'dilution' will be necessary in this country, a description of the method which appeared in a recent number of *The Mechanical World* is of interest. The operation given as a general example is that of drilling the small holes in fuses. Ordinarily such work would be done by skilled drillers, who would grind their drills, fix them and the fuse in the machine, and operate the machine. To do all this successfully requires greater accuracy than the women can acquire in the time available. Therefore, grinding the drills and setting them and the fuses in the machines is still done by skilled men, but the rest of the work is done by women. The result is to substitute say two skilled men and ten women for ten skilled men. While it is probable that such 'dilution' would meet with the disapproval of the labor-unions in this country, it should be remembered that the unions were probably stronger before the War in Great Britain than in America. We do not believe that American union-men are any less patriotic than their British associates.

DISSATISFACTION with Congressional delays is frequently expressed, and it does seem as if more should have been accomplished in four months. It should be remembered, however, that this is a democracy and a measure of freedom of discussion is essential to a democracy. Doubtless the Reichstag could have accomplished a great deal more than Congress has done, provided a substitution could have been made, but who wants to substitute the Reichstag for Congress? Before the War we were free but not very efficient. Let us hope that when it closes we shall be just as free and a great deal more efficient.

ONE way to help win the War is to stop asking the railroads and other public-service corporations to spend money in places where it is not absolutely necessary. A $100,000 depot is a nice thing to show tourists and to put on the letterheads of the Chamber of Commerce, but it is hardly likely that it helps toward winning the War, and it ties up that much capital that could be devoted to something else. Again a main telephone line is convenient, but perhaps you could manage on a party-line that is already in place. Wire is hard to obtain just now. This does not mean that necessary construction must cease; there will be plenty of that anyway, but superfluous work should be eliminated.

USE of local materials wherever feasible is another way to help the transportation companies to do their part in winning the War. We are all acquainted with a number of instances where the use of the imported article is simply a fad, and it goes without saying that such practices should be discontinued immediately. There are, however, a number of cases in engineering construction as well as in other lines of activity where the local material is not quite so suitable as something that comes from somewhere else. In such cases, a little study may show that by some relatively unimportant changes it may be possible to use the local material without harming the structure. In ordinary times, when the railroads had abundant facilities for handling the traffic, it probably would not be worth while to make such investigations. At the present time it is a patriotic duty to do so.

THE car-shortage situation is becoming less acute in most parts of the country in spite of increased transportation-needs. This is partly because of measures taken by the railroads to expedite the movement of freight-cars, but is more particularly the result of the campaign for educating shippers. After many years of experiencing a car-shortage during part of almost every season and frequently during most of the year, we have suddenly waked up to the fact that freight-cars, on an average, are loaded to about half their capacity. A comparatively small increase in car-loadings would eliminate the present shortage entirely. Furthermore, consignees are only too fond of economizing on warehouse space by using cars instead. One form of engineering construc-

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tion that should not be halted by the War is the construction of warehouses and other storage-facilities so that freight-cars on arriving at their destination may be unloaded promptly and released for their proper work of transportation.

ANOTHER way to help to win the War by rational economizing is to use bulk cement whenever possible. Where the amount used is small this, of course, is not practicable, but where cement is used directly from the car at the rate of 50 barrels or more per day, bulk cement is the best. The principal advantages are in the elimination of all the trouble from lost and damaged sacks as well as the handling of good sacks so that they may be returned to the mill. It is also true that the damage from dampness, which is sometimes unavoidable, is less with bulk than with sacked cement.

INCREASED freight-rates requested by the railroads have, with a few exceptions, been denied by the Interstate Commerce Commission. The railroads asked for a horizontal increase of 15% in general, but the Commission granted only a partial increase to some of the Eastern lines and left rates in the West as they were. The Commission took the ground that with the exception of the Eastern lines already mentioned, the railroads' statements of earnings and expenses at the present time, when traffic is at its height, did not indicate that increased rates were needed. This is admittedly a hard question to determine, but the fact remains that the public shows reluctance about buying railroad securities. Doubtless the disclosures of mismanagement and dishonesty in the operation of some companies have a good deal to do with this reluctance, but practically all railroads, even the most efficiently managed, have had the same difficulty. Sooner or later, both the general public and their official representatives will have to realize that a public utility performing a needed service must be allowed to charge rates sufficient to make its securities attractive to investors, or else the governing body must be ready to take over the operation of the utility at a fair valuation. Public policy and common morality both demand that one alternative or the other be chosen. There is no middle course.

HOW to treat a bid that is apparently too low is a hard problem for the conscientious engineer, but we believe that Mr. E. H. Annear, county surveyor of Stanislaus county, California, has approximately the best system. That county voted bonds for $1,482,000 last fall for a county highway system. Most of the work was awarded early in the season when many highway contractors had idle outfits that they were eager to put to work. The result was close figuring and some remarkably low bids. To insure absolute fairness, on each contract where the low bid was considerably below the engineer's estimate, the contractor was given an opportunity to withdraw his bid. In no case, however, was a bid withdrawn. Nevertheless, by the time the last stretches of road were ready to be awarded some time in April, the contractors were not quite so anxious for work in Stanislaus county, and there is one 14-mile section of concrete highway that remains to be awarded because no one has been willing to bid on the work. The rest of the system is under way at prices that do not give much hope of profit to the contractor, particularly when the rising prices of materials and labor are considered. It is an unfortunate situation for the contractors, but it is hard to see how they can be given any relief.

GOVERNMENT railroad construction in Alaska is discussed in a statement issued by Mr. Franklin K. Lane, Secretary of the Interior. The main line is now under construction between Seward and Fairbanks, 470 miles, of which 150 miles is now in operation. It is estimated that coal from the Matanuska field can be delivered for the needs of the Navy and the Pacific Coast in general in the early summer of 1918. It will also be possible soon to deliver coal from the Nenana field at Fairbanks, where mining operations have been seriously hampered by lack of fuel. Several rich valleys containing considerable agricultural land will also be opened for development.

IN our July number we urged that county officials take steps toward more effective fighting of forest, grain, and other fires outside of incorporated places. Since then the Board of Supervisors of Solano county, California, has made an appropriation to equip 13 fire-stations in various parts of the county. Each station is to have an automobile-trailer, equipped with fire-extinguishers, shovels, and other fire-fighting apparatus. Arrangements have been made with automobile-owners at each station for the use of their machines in hauling the trailers to any point where there is a fire. A volunteer fire-fighting force has also been organized among the residents in the vicinity of each station. In Solano county the chief danger is from grain fires. In Sonoma county, on the other hand, there is considerable loss each year from forest fires, not only in the amount of timber destroyed but also in the damage to 'summer-resort territory.' During the last few days considerable damage has been done by a forest fire in the Russian River district. The country is sparsely settled and the few residents were assisted by as many section-hands and other railroad employees as could be spared from their ordinary duties. The fire-wardens have been handicapped in enlisting fire-fighters by the fact that they could not guarantee payment from the county funds. In a letter to one of the local newspapers, Mr. W. S. Palmer, president of the Northwestern Pacific Railroad, called attention to the need of adequate provision by the county for fighting forest fires, and stated that, in his opinion, proper organization could reduce the annual fire-loss materially. It will be several months before rains and cool weather reduce the fire-hazard to any considerable extent and action by county officials in this direction is a good way to help win the War.

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